FLIGHT

The AIRCRAFT ENGINEER & AIRSHIPS

First Aero Weekly in the World

Founder and Editor: STANLEY SPOONER

A Journal devoted to the Interests, Practice, and Progress of Aerial Locomotion and Transport

OFFICIAL ORGAN OF THE ROYAL AERO CLUB OF THE UNITED KINGDOM

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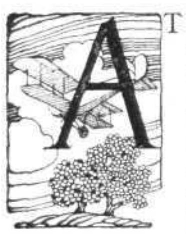
DIARY OF FORTHCOMING EVENTS

Club Secretaries and others desirous of announcing the dates of important fixtures are invited to send particulars for inclusion in the following list:—

1926

April 29	Lieut.-Col. V. C. Richmond. "Results of Recent Airship Flight Tests," before R.Ae.S.
May 11	Capt. W. H. Sayers. "The Modern Theory of Aerofoils and its Application to Aeroplane Design," before Inst.Ae.E.
May 19	Inst. Ae.E. visit to the National Physical Laboratory, Teddington.
May 30	Gordon-Bennett Balloon Race, Antwerp.
June 11–13	Belgian Light 'Plane and Touring Aeroplane Competition.
June 12	Inst. Ae.E. visit to Croydon Aerodrome.
July 9–10	King's Cup Race, Hendon.
July 11–27	German Seaplane Competition at Warnemunde.
Aug. 9-15	French Light 'Plane Competition.
Sept. 10-17	Two-Seater Light Aeroplane Competition, Lympne.
Sept. 18	Grosvenor Challenge Cup, at Lympne.

EDITORIAL COMMENT.



AT last the long-expected regulations for the British light 'plane competition have been issued and are published in this week's issue of FLIGHT. As mentioned in these notes last week, the competition, which is to be held under the rules of the Royal Aero Club, is to be in the form of a reliability trial, the various "circuits" to be covered radiating in different directions from the aerodrome at Lympne, where competitors have to land at the end of each "circuit."

The Lympne Competition

It is quite evident that the German "Rundflug" of last year has been taken as a pattern in mapping out the courses, and although it would seem more logical to have chosen one of the London aerodromes as the centre, there were doubtless practical considerations which led those responsible for the organisation to choose Lympne. London is to some extent brought into the scheme by the fact of making the Croydon aerodrome the turning point on one day of the competition, and for the rest a number of South Coast seaside resorts have been chosen as turning points, where consequently thousands of visitors will be able to see the competing machines.

As regards the nature of the competition itself, the regulations allow designers very considerable freedom, at any rate on paper, the only stipulations or restrictions being that the engine must not weigh more than 170 lbs., and that the useful load, apart from fuel, must be at least 340 lbs. Otherwise designers may please themselves in the matter of power plant and load carried.

An indirect restriction is provided by choosing as a basis for the award of points the useful load carried over the distance of the whole course (nearly 2,000 miles) per unit of fuel consumed during the flight, but provided the useful load equals or exceeds the 340 lbs. a designer may use a small engine and carry the minimum load or a larger engine carrying a larger load. Thus obviously, if one machine does 30 miles per gallon, and carries the minimum of 340 lbs., it will consume about 66 gallons for the whole distance,

and its "figure of merit" will be $\frac{340}{66} = 5 \cdot 15$. Another machine, with a larger engine, which only does, for example, 20 miles per gallon, will consume 100 gallons, and will, therefore, require to carry, in order to obtain the same "figure of merit," a useful load of 515 lbs. There is plenty of room for shrewd guessing as to which will pay the better, although practical limitations are, to some extent, imposed by the somewhat limited number of suitable engines available.

The regulations are not very clear or explicit on one or two points, but it is gathered that if a competitor fails to complete one of the circuits on any day, within the time limits given, he will be disqualified from taking any further part in the competition. Thus it will be a rather delicate problem for designers to settle whether to fly with a fairly small load, and running the engines fairly well throttled down, thus "saving" them, or to aim at the greatest possible load, trusting to the engine to last without breaking down when run somewhere near full power for most of the time.

It will be observed that no premium is placed on speed, at least directly, provided the machines average at least 50 m.p.h. around the course. Indirectly, however, speed does come into consideration, since obviously if two machines carry the same useful load and are fitted with engines having the same fuel consumption, the faster machine will consume less fuel for a given distance, apart from the fact that a slow machine is more seriously affected by head winds than is a fast machine. Altogether the regulations will give designers plenty to think about, and it will be very interesting to see the interpretation of the various designers. It appears likely that the number of new machines to be built specially for the competition will not be very large, but several of the 1924 two-seaters may be expected to take part. In this connection a rather interesting point has arisen. One of the 1924 Lympne two-seaters was found to come within all the stipulations, with one possible exception—the cockpit width, if measured to the fabric covering, was just above that required, but if measured to the fuselage struts, the width was less than that stipulated. The point was, we understand, taken up with the Royal Aero Club, and the ruling was obtained that measuring the width to the fabric would be accepted. We think this instance deserves to be mentioned, since there may be other machines in which the same point will arise.

The Tailless Aeroplane

History has a curious habit of repeating itself. A recent example was provided last week when Capt. Hill read, before the Royal Aeronautical Society, a paper describing his experiments with a tailless aeroplane. Although incorporating a number of novel features, the "Pterodactyl," as Capt. Hill has named his machine, is evidently a direct descendant of the pre-war Dunne machines. In fact, in his paper, Capt. Hill described his machine as "a natural development from old-time tailless aeroplanes, among which that designed by Lieut. J. W. Dunne achieved the greatest measure of success." In common with the Dunne machines the "Pterodactyl" has control surfaces at the wing tips which, when worked together, act as elevators, and worked separately give lateral control. Also in common with the Dunne, the new machine relies upon back-swept wings and a wash-out of incidence for the maintenance of a stationary centre of pressure. Here, however, the similarity ends. In the Hill machine the wing-tip organs are not used as rudders, two separate surfaces being provided for directional control, and it may well be that it is in the introduction of these rudders that the greatest merit of the new machine lies, since they do give adequate directional control, a feature which was one of the shortcomings of the early Dunne machines.

As to the future of the tailless machine it would seem that two features in particular entitle it to development. It has no definite stalling point, and it is under perfect control when descending at an angle that would, in a normal machine, represent stalled flight. A very practical advantage of the tailless machine is that it appears at the moment, although further work is required to establish this definitely, to make possible a return to the "pusher" type of machine without loss of performance. There has never been a more comfortable aeroplane, from the passenger's point of view, than the pusher, and for commercial machines the revival of the type might have many advantages. One more feature deserves to be mentioned. When the "Pterodactyl" is descending in what may be described as the stalled state, it can be brought into an unstalled state without loss of height. This is, of course, a characteristic that should add immensely to the safety of the tailless aeroplane. Whatever its ultimate future the tailless machine is of more than ordinary interest, and Capt. Hill has done a very excellent piece of research work in reviving interest in the type.

Portuguese Lisbon-Azores Flight

ON April 20, two Portuguese Naval aviators, Lieuts. Moreira and Terreira, left Lisbon in a Fokker seaplane to fly to the Azores and back. They were forced to descend about 30 miles north of Porto Santo, where they were found by a fishing boat, and were later towed by a destroyer into Madeira, whence they flew on to Funchal, on April 22.

A French New York-Paris Flight

CAPT. FONCK, the famous French Ace, left Paris on April 20 for America, in order to make arrangements for a flight this summer from New York to Paris in a three-engined machine of his own design, which is being built in America.

Spanish Flight to Manila

A SPECIAL order issued by the Air Ministry states that the following telegrams have been exchanged between His Majesty the King of Spain and His Majesty the King in connection with the recent rescue of Spanish aviators in the desert near Amman. From H.M. King Alfonso :—

"My people, the Spanish Army and myself are sincerely and immensely grateful for the splendid and successful search operations in finding in the desert Captain Estevez and his mechanic. Please convey these feelings of gratitude to your brilliant and courageous Air Force for their perilous and noble enterprise. I beg you to allow me to have the pleasure to confer a decoration as a token of recognition and appreciation of my nation to the Chiefs and Officers who have distinguished themselves in this work of humanity and fellowship."

To which H.M. the King sent the following reply :—

"I much appreciate your kind telegram and rejoice to think my Air Force were able to rescue Captain Estevez and his mechanic from their perilous position in the desert. I know how gratified all ranks of the Force will be by your message of congratulations and your wish, to which I gladly assent, to confer a decoration on those who were concerned in this successful enterprise."

The two remaining Spanish pilots, Capts. Gallarza and Loriga, are, meanwhile, approaching the end of their journey. On April 21 they left Calcutta and flew to Rangoon, and proceeded the next day to Bangkok.

WIRELESS EQUIPMENT OF THE "NORGE" AIRSHIP

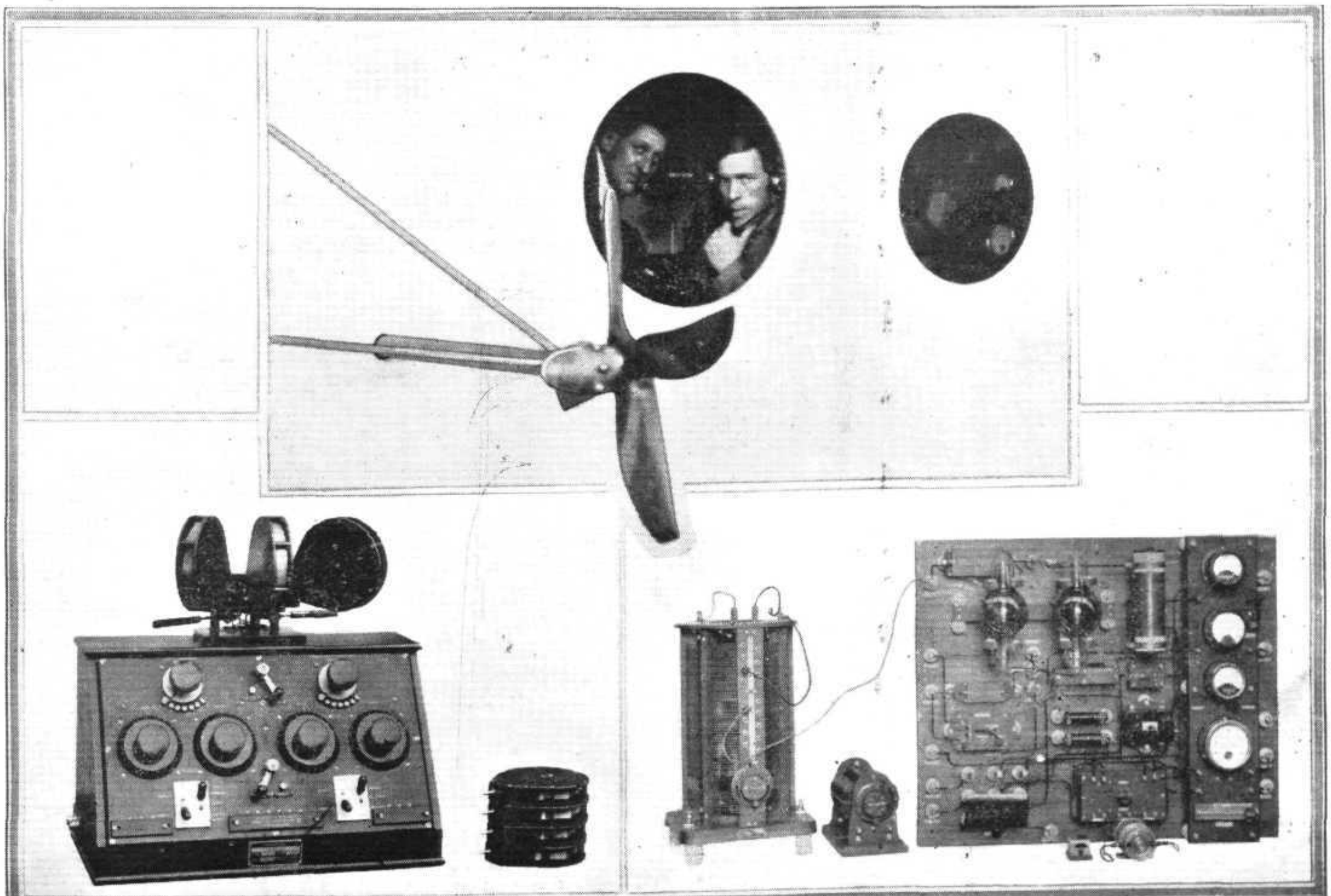
IN our issue for March 18 last we made brief reference to the wireless equipment installed by Marconi's Wireless Telegraph Co. of Marconi House, Strand, W.C.2, in Capt. Amundsen's Polar airship "Norge," and this week we are able to give our readers some further details of this important item of the expedition.

As previously stated, arrangements have been made whereby the airship has been equipped with special transmitting and receiving apparatus which will enable the commander to keep in touch with either ship or land stations up to very considerable distances.

The airship will, in fact, be in a position to maintain com-

[Photo by Marconi Wireless Telegraph Co.

WIRELESS EQUIPMENT OF "NORGE" POLAR AIRSHIP: The Italian-built semi-rigid airship "Norge" in which Capt. Amundsen is making his flight to the North Pole. This view shows the wireless direction-finder loops encircling the envelope of the ship.



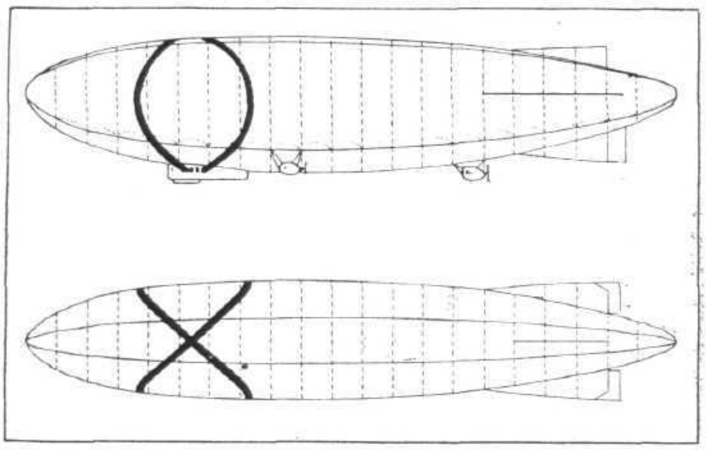
[Photos by Central News and Marconi Co.

WIRELESS EQUIPMENT OF "NORGE" POLAR AIRSHIP: The top view shows the wireless generator propeller mounted outside the "W.T." cabin. Below, on the left, is shown the long-wave tuner, with plug-in coils, and on the right the $\frac{1}{2}$-kw. transmitting panel.

munication with the outside world throughout its entire voyage through Arctic solitudes. The range of the transmitter and receiver will probably be, in regions where interference is not great, anything up to 2,000 miles. On the first stage of the airship's journey to the Pole, from Rome to Pulham, Norfolk, regular two-way communication with the Air Ministry, London, was established when the "Norge" was over the south coast of France, and was maintained throughout the remainder of the voyage. Reception appeared to be only limited by the interference of local stations. A good deal of interference can be eliminated by receiving on the D.F. loops and putting minimum on the interfering station. In the Arctic, where interference will be negligible, no difficulty at all should be experienced.

Of particular interest is the direction-finding system which will enable the navigators accurately to determine their position and course despite the fact that the compasses will have reduced navigational value in the region of the Pole itself, due to the earth's magnetic field effect and the fact that actually at the Pole all direction will be due south.

The transmitter is an adaptation of the Marconi 0·5 kw. Type U set and is suitable for continuous wave and tonic train signalling. In order to meet the special conditions obtaining in the airship and to utilise to the best advantage the very limited space available the principal components are mounted on a light teak baseboard. These components comprise two Type T 250 valves, H.F. choke, reaction condensers, send-receive swith, C.W.-I.C.W. switch, and measuring instruments for indicating aerial current, feed current, high-tension volts, and filament volts.



WIRELESS EQUIPMENT OF "NORGE" POLAR AIRSHIP: Diagram showing the arrangement of the wireless Direction-Finder aerial loops, which are mounted diagonally round the envelope of the airship.

The aerial tuning inductance and variometer form separate units and, used in conjunction with the airship's trailing aerial, covers a wave-range of approximately 550 to 1,500 metres. On the transmitter six to seven amps. may be obtained in the aerial on the optimum waves and four to five on the extremes. The two oscillating valves are connected in parallel, and continuous wave signalling is effected by a manipulating key connected in the grid circuit. For tonic train signalling the grid circuit is interrupted by a small rotary interrupter.

Power for the anode circuits of the transmitting valves and for charging the filament lighting batteries is derived from a combined H.T. and L.T. direct current generator developing 133 milliamperes at 3,000 volts and 14 amperes at 14 volts. The generator is fitted just astern of the wireless cabin on a locker and is driven by an air-screw with a right-angled bevel drive, as shown in one of the accompanying illustrations. The centre of the propeller is about 5 ft. from the side of the gondola, and the angle at which the propeller faces the air stream can be varied from inside the cabin by a special lever which may be adjusted and locked to suit the speed at which the ship is travelling or the rate required by the dynamo. The propeller is of the four-bladed type and is capable of developing about 3 h.p.

For emergency purposes a horizontally-opposed twin cylinder petrol engine of $2\frac{3}{4}$ h.p. is mounted on a lightly constructed tubular steel framework which can be quickly fixed just outside the gondola. The generator that is driven from the air-screw can be quickly attached to this framework by means of wing nuts.

A switchboard fitted with an automatic cut-out, ammeter, voltmeter and "W/T-Charge" change-over switch enables the low tension batteries to float across the low tension side of the generator during transmission or to be charged when the transmitter and receiver are not in use.

A special type of fairlead is fitted in the base of the gondola for the trailing aerial, which is 300 ft. long. This fairhead enables a new aerial and weight to be fitted while the airship is in flight should it be necessary. An ordinary paxolin aerial winch with an expanding brake is supplied.

Special Marconi receiving apparatus is utilised both for direction finding and for ordinary service reception. As in all aircraft, economy of space and the minimum of weight are essential features and to meet these requirements several of the units are utilised both for direction finding and service reception purposes.

A Marconi short wave two-valve, receiver, with a wave-range of 10-100 metres is carried. This is intended for communication with Point Barrow, where a short wave transmitter is installed. The aerial for this apparatus is a short length of wire fixed between the wireless cabin and one of the engine gondolas. The receiver operates on the batteries carried for normal working.

The direction finder loops shown in the accompanying diagram, are fitted diagonally round the outside of the envelope the centre of the loops coinciding with the lead-in to the wireless cabin. The loops consist of two turns of wire, spaced about 9 in. apart. The loops are doped to the fabric with linen tape, forming a neat and unobtrusive but very efficient fitting.

Inside the cabin 8 terminals are fitted on an ebonite panel to which the ends of the loops are connected. This enables the loops to be put in either parallel or series, as might be found most advantageous on the wave length being received. Reception on the radiogoniometer utilises practically the same circuits as are used for service reception with the trailing aerial.

A radiogoniometer unit and a three-range transformer unit are used in conjunction with a high frequency amplifying detector and a low frequency magnifier. A low frequency note filter is also provided which can be inserted, when desired, into the circuit between the output terminals of the amplifier and the input terminals of the note magnifier. A local oscillation generator is provided to enable bearings to be taken on the long continuous wave stations.

The transformer unit comprises three air-core transformers with condensers for secondary circuit tuning covering wave ranges of 2,000 to 5,000, 4,000 to 10,000 and 10,000 to 25,000 metres. The amplifier is provided with six type V 24, valves, with resistance-transformer coupling for high frequency magnification and a type QX valve for rectification.

The note filter circuit is provided with a single type V 24 valve and an oscillating circuit tuned by means of a variable condenser. The low frequency magnifier has two transformer coupled type V 24 valves, which can be switched into circuit according to the conditions of reception.

The local oscillation generator utilises one type V 24 valve, which can be switched into circuit for receiving continuous wave signals. A 66-volt dry cell battery is tapped at suitable points for supply current to the anode circuits of the receiving valves. The valve filaments are run off the battery used for lighting the filaments of the transmitting valves.

For the reception of continuous wave, spark and telephone service messages a "plug-in" coil tuner covering a wave-range of 300 to 25,000 metres is connected to the high-frequency amplifier in place of the transformer and radiogoniometer units used for direction finding.

The tuner is a coupled circuit instrument and is provided with reaction coupling to the grid circuit. Eleven "plug-in" coils are provided to cover the full wave-range, any one of which can be inserted in the aerial, grid, or reaction circuit according to the wave-length being received.

The service receiver utilises the same aerial as that used for the transmitter, the aerial being connected either to the receiver or transmitter by means of the Send-Receive switch mounted on the transmitter panel.

A narrow table is provided for the operator's writing and for the manipulating key on the starboard outside wall. Under the left-hand side of the table the transmitter inductance is fitted to the floor. A variometer for fine transmitter wave adjustments is also fitted on the left under the table.

A double-pole change-over switch is fitted in the cabin and the 12-volt lighting mains for the ship are brought to this as well as the wireless 12-volt supply. This enables the ship's accumulator and the wireless accumulator to be charged in parallel from the wireless generator, and if the ship's main gives out current can be supplied from the wireless accumulator, and *vice versa.* The accumulators used for the ship's mains and for the Marconi apparatus are of the thin plate high discharge type and non-spillable.

The Royal Aero Club of the United Kingdom

OFFICIAL NOTICES TO MEMBERS

COMMITTEE MEETING

A MEETING of the Committee was held on Thursday, April 22, 1926, when there were present: Lieut.-Col. F. K. McClean, A.F.C., in the chair; Air Vice-Marshal Sir W. S. Brancker, K.C.B.; Ernest C. Bucknall; Lieut.-Col. M. O. Darby, O.B.E.; Maj. H. Hemming, A.F.C.; E. J. B. How; Wing-Commander T. O'B. Hubbard, M.C., A.F.C.; F. Handley Page, C.B.E.; and the Secretary.

Election of Members.—The following new members were elected :—

William Thomson Hay.
Flight-Lieut. Matthew Alistair Simpson.
Archer Statham White.
John Jacob Hofer.
Cecil Walter Langlands.
George Frederick Wanklyn Cobbold.
Kenneth Vernon Wright.
Flight-Lieut. Donald William Clappen.
Frank Samuel Gaylor.
Gordon Percy Olley.
The Hon. Ralph Alexander Cochrane.
John Alfred Lincoln.
Flying Officer William Henry Stiles.
Pilot Officer Maurice Brunton.
George Gordon Kent.
Samuel Clement Tucker.

Aviators' Certificates.—The following aviators' certificates were granted :—

7985. Ralph England Hawkins, April 15, 1923.
7986. Cyril Comyn Musselwhite, April 28, 1923.
7987. Percy Fraser Clarke, March 30, 1926.
7988. Francis Henry Kennedy, December 3, 1924.
7989. William Thomson Hay, April 14, 1926.
7990. Bernard Henry Smith, April 1, 1926.
7991. Reginald Robert Williams, April 5, 1926.
7992. Sydney Alfred Crabtree, April 5, 1926.
7993. Haliburton Hume Leech, April 10, 1926.

Election of Stewards.—The Stewards of the Royal Aero Club for the year 1926 were elected as follows :—

Brig.-Gen. the Duke of Atholl, K.T., G.C.V.O., C.B., D.S.O.
The Right Hon. Lord Hugh Cecil, M.P.
Brig.-Gen. Sir Capel Holden, K.C.B., F.R.S.
Lieut.-Col. J. T. C. Moore-Brabazon, M.C., M.P.
Admiral of the Fleet the Right Hon. Sir Edward Seymour, G.C.B., O.M.

ELECTION OF SUB-COMMITTEES

House.—Ernest C. Bucknall, Maj. Herbert J. Corin, F. P. Dickson, E. J. B. How, D. C. MacLachlan, J. Stewart Mallam, Capt. L. V. Pearkes, Maj. S. V. Sippe, D.S.O.

Finance.—Ernest C. Bucknall, Lieut.-Col. M. O. Darby, J. Stewart Mallam, F. Handley Page, C.B.E.

Flying Services Fund.—Lieut.-Col. Alan Dore, D.S.O.; Chester Fox; D. C. MacLachlan; Wing-Com. T. O'B. Hubbard, M.C., A.F.C.

Racing.—Air Vice-Marshal Sir W. S. Brancker, K.C.B.; Lieut.-Col. W. A. Bristow; A. S. Butler; Capt. R. J. Goodman Crouch; Lieut.-Col. M. O. Darby; Lord Edward A. Grosvenor; Maj. H. Hemming; Maj. R. H. Mayo; Howard T. Wright; Capt. C. B. Wilson, M.C.

Technical.—Maj. T. M. Barlow; Maj. J. S. Buchanan, O.B.E.; W. O. Manning; Maj. R. H. Mayo; Lieut.-Col. M. O'Gorman, C.B.; Lieut.-Col. H. W. S. Outram, C.B.E.; Wing-Com. T. S. Rippon, C.B.E.; Squadron-Leader M. E. A. Wright, A.F.C.

Joint Standing Committee (R.Ae.C. and S.B.A.C.).—Lieut.-Col. F. K. McClean, A.F.C.; Air Vice-Marshal Sir W. S. Brancker, K.C.B.; Lord Edward A. Grosvenor; Capt. C. B. Wilson, M.C.

Airship Club.—The arrangements entered into with the Airship Club for the use of 3, Clifford Street, as registered address and for secretarial work were reported and confirmed.

Light Aeroplane Competition, 1926.—The reports of the meetings of the Joint Committee of the Club, Air Ministry and Society of British Aircraft Constructors were received and confirmed and the Regulations approved.

Light Aeroplane Clubs.—The applications from the London, Lancashire and Newcastle Aero Clubs for a grant from the fund placed at the disposal of the Royal Aero Club by the Petroleum Distributors Committee were considered. A modification in the terms of the gift having been agreed to by the Petroleum Distributors Committee, it was decided to make the following grants :—

London Aeroplane Club	£200
Lancashire Aero Club	£200
Newcastle-upon-Tyne Aero Club	£200

"Bristol" Jupiter Endurance Test.—It was decided to issue a Royal Aero Club Certificate of Performance to the Bristol Aeroplane Co., Ltd., in connection with the endurance test of the "Bristol" Jupiter carried out under the supervision of the A.I.D. Air Ministry.

Honorary Membership.—Capt. William C. Watts, U.S.N., was elected a Temporary Honorary Member of the Club on his taking over duties of Naval Attache at the American Embassy as successor to Rear-Admiral L. McNamee.

Offices: THE ROYAL AERO CLUB,
3, CLIFFORD STREET, LONDON, W. 1.
H. E. PERRIN Secretary,

LIGHT 'PLANE CLUB DOINGS

London Aeroplane Club

THE flying time for the week ending April 25 was 21 hrs. 30 mins. The following members had flying instruction :—Miss O'Brien, Sir John Rhodes, Bart., A. Lees, R. C. Presland, N. J. Hulbert, E. D. Moss, R. J. Bevington, S. J. Hofer, G. Wallcousins, D. Hamilton, J. Barros, A. Southgate, J. H. Simson, O. J. Tapper, H. Solomon, E. K. Blyth, A. P. Hunt, J. Eady, L. J. C. Mitchell, R. L. Hare, E. P. Brough, J. S. M. Michie, F. Adams.

The following members flew solo :—Squad.-Leader M. E. A. Wright, Major K. M. Beaumont, J. S. M. Michie, E. P. Brough, A. P. Hunt.

The D.H. "Moth" G-EBMF, which has been purchased by the Club, was delivered on Saturday last, and for the first time since January the Club had two machines available. This enabled five members to do solo flying on that day. The third D.H. "Moth" should be taken over during this week.

The following donations have been received towards the purchase of G-EBMF :—O. J. Mastrand, £1; J. G. Day, £2 2s.; B. B. Tucker, £1; T. C. Sharwood, £2; Total to date, £703 5s.

The Lancashire Aero Club

FLYING details for the week ending April 25 are :—

Dual with Mr. T. N. Stack: Messrs. Abdulla, 2 hrs. 10 mins.; A. Benson, 1 hr. 25 mins.; H. Hardy, 1 hr. 15 mins.; A. Macnair, 1 hr. 5 mins.; C. Agar, 55 mins.; Wade, 55 mins.; G. Slater, 50 mins.; Davidson, 45 mins.; S. Brown, 40 mins.; R. R. Williams, 35 mins.; Jowett, 35 mins.; Casta, 30 mins.; Braid, 30 mins.; Anderson, 30 mins.; A. Goodyear, 25 mins. E. Steele, 20 mins.; H. S. Stern, 20 mins.; Jackson, 20 mins.; S. Crabtree, 15 mins.; Mensies, 15 mins.; Crosthwaite, 15 mins.; F. Catterall, 20 mins.; Proctor, 20 mins.; Lilley, 10 mins.

With Mr. J. C. Cantrill: Messrs. A. Benson, 55 mins.; H. S. Stern, 30 mins.; Lilley, 30 mins.; H. Hardy, 25 mins.; A. Goodyear, 20 mins.

With Mr. J. J. Scholes: Messrs. F. Catterall, 35 mins.; C. Agar, 25 mins.; P. Nicholson, 10 mins.; Casta, 10 mins.

Solo flights were made by: Messrs. C. G. S. Parker, 2 hrs. 35 mins.; M. Lacayo, 55 mins.; A. Goodfellow, 30 mins.; J. Wilkinson, 30 mins.; C. Slater, 20 mins.; A. Macnair, 10 mins.

During the week G. A. S. Parker did the necessary tests for his "A" Licence, and Messrs. A. Macnair and C. Slater did their first solos.

Newcastle-upon-Tyne Aero Club

FLYING report for week ending April 25 :—LX, 21 hrs. 40 mins.; LY, 9 hrs. 10 mins. Total, 30 hrs. 50 mins., made up as follows: Dual with Major Packman, 17 hrs. 10 mins.; solo, 6 hrs.; passenger flights, 6 hrs. 55 mins.; tests (six), 45 mins.

Though the weather has been very unsettled, it has been possible to maintain a good average through having two machines on service again, and a further record was made on Sunday, when the total for the day was 8 hrs. 35 mins. During the week the Club passed the 500 hours' flying time mark.

The following members had instruction :—Mrs. Marcks, Miss Leathart, Messrs. George, McGuiness, Edwards, Bainbridge, Miesagaes, Thirlwall, B. I. Sutherland, P. F. Heppell (secondary dual), L. Smith, Twine, C. Thompson, Shaw, Bruce, J. Bell, J. G. Edmundson, A. Bell.

The following pilot members flew with passengers whose names are given :—

Mr. Baxter Ellis with Mrs. Dodds, Mr. and Mrs. Urwin, Miss Stafford, Mr. Sutherland and Mr. Bulmer.

Mr. R. N. Thompson with Miss Baker, Miss Thompson and Mr. Lawson.

Mr. N. S. Todd with Mr. Bell.

Mr. R. M. Stobie with Miss W. Urwin, Miss M. Bowran, Miss A. Scott.

Mr. Packman flew with the following passengers :—Mr. E. Wingle, Mr. H. Carruthers, Mr. Shaillise, Mr. Moberley, Miss Parkin, Mr. Pattle, Mr. Hughes, Mr. Beattey, Mr. Robson, Mr. and Mrs. Wedderburn, Mr. and Mrs. Urwin, Miss Snowball, Miss Dotchin, Miss Middleton, and Master Middleton. Mrs. Wedderburn flew last week, but her name was inadvertently omitted from the list given.

Over two hours was flown on the "Gull," Mr. Ellis, Mr. Heppell and Major Packman flying at different times, Mr. Heppell attempting to break the existing height record (since the machine came north) of 900 ft. on Wednesday, but the barograph did not function properly. Major Packman reached 2,000 feet on Saturday. It appears that this will be difficult to beat, but it is known that the machine has been flown at 3,000 ft. by Mr. Lancaster Parker.

TWO-SEATER LIGHT AEROPLANE COMPETITION, 1926

(Under the Competition Rules of the Royal Aero Club)

THE Supplementary Regulations for the Two-Seater Light 'Plane Competition, to be held at Lympne from September 10 to 18, 1926, have now been issued. The competition, which is being held under the competition rules of the Royal Aero Club for prizes totalling £5,000, offered by the proprietors of the *Daily Mail*, is a purely British one. Following are the regulations :—

SUPPLEMENTARY REGULATIONS I

1. *Organisation*.—The competition will be conducted by the Royal Aero Club, under the Competition Rules of the Royal Aero Club.

2. *Light Aeroplane*.—The competition is open to any aeroplane, the weight of the engine of which does not exceed 170 lbs.

NOTE :—The weight of the engine includes carburettor and induction system, complete ignition equipment, air screw hub and fastenings, exhaust pipes (if any) and radiator, pipes and water (if any).

3. *Two-Seater Dual Control*.—The aeroplane must be a two-seater fitted with dual control, and an air-speed indicator must be visible from either seat. The heads of the pilot and passenger must not be enclosed. The seating and control must be capable of accommodating a normal person of 6 ft. height.

A cockpit width of not less than 24 ins., to be measured at the seat level, must be provided for both pilot and passenger.

In the case of a side-by-side machine the cockpit width must not be less than 44 ins., to be measured at the seat level.

In the case of a machine with staggered seats, a width of not less than 24 ins. must be provided for both pilot and passenger, to be measured at the seat level.

The top of the control column should be free to move in a fore and aft direction through a distance of not less than 15 ins. The distance between the seats of the pilot and passenger must not exceed 5 ft.

4. *British Manufacture*.—The aeroplane, including the engine and ignition system, must have been designed and constructed in the British Empire.

5. *Competitors*.—Entrants and pilots must be British subjects.

6. *Fuel*.—The ingredients of the fuels must be commercially obtainable in bulk in this country.

The fuel used by all engines in the competition shall be substantially the same as that used in the respective type tests for Certificates of Airworthiness, and shall be within 5 per cent. of the specific gravity of such fuel.

The unit of fuel is a unit of weight.

All refuelling in the competition must be done at Lympne Aerodrome under the supervision of the Official Measurer.

All fuel weighed into the tank from the start of the competition will be counted for consumption, and all testing or running-up of the engine must be carried out on this fuel. Fuel taken by the Official Measurer from the tank will be credited.

7. *Load to be Carried*.—The load to be carried, exclusive of fuel and oil, must not be less than 340 lbs., which figure includes the weight of the pilot and passenger (if carried). If there is no passenger the balance of the 340 lbs. must be carried in the spare seat. Additional weight may be carried anywhere in the aeroplane as useful load provided that the total weight of the aeroplane does not exceed the figure allowed in the Certificate of Airworthiness.

The carrying of a passenger is optional except in the Eliminating Test "B," in which case it is not permitted.

8. *Certificates of Airworthiness*.—A certificate of airworthiness for the aeroplane must be obtained and produced to the Royal Aero Club one week before the opening date of the competition.

9. *Air Navigation Regulations*.—Competitors must comply with the Air Navigation Regulations in force, subject to any concessions which may be made by the Air Ministry for this competition.

10. *Accommodation*.—Free accommodation for competing aeroplanes will be available at Lympne Aerodrome from Tuesday, September 7, 1926.

11. *Identification*.—Each aeroplane will be allotted a number, which must be painted in black on a white surface on each side of the fuselage and on the lower surface of each of the lower main planes. This number must be as large as the surface permits. Government registration marks are not necessary for this competition.

12. *Flying Time*.—The competition will be open each day at 8 a.m. and will close at 8 p.m. Competitors will not be observed or timed after that hour.

The stewards may prohibit any flying in the competition if, in their opinion, the weather conditions justify such action.

The stewards may extend the flying time in the event of any loss of time on account of unfavourable weather.

13. *Change of Pilots*.—The changing of pilots is permitted, but any change must be notified beforehand and the weight adjusted.

14. *Repairs*.—The same aeroplane and engine must be used throughout the competition, but repairs and certain replacements as scheduled will be allowed.

Schedule of replacements permitted :—

Engine Parts.—Petrol and oil filters ; propellers of the same design, construction and dimensions ; sparking plugs and ignition wires ; valves and springs ; ignition systems.

Aeroplane Parts.—Wheels ; tyres ; tail skids ; wing tip skids.

Repairs and replacements of a minor nature, with the previous consent of the stewards.

Any competitor discarding part of or otherwise altering the aeroplane during the competition, so that it differs in any way from that which was presented to the officials in the first place, will be disqualified.

15. *Official Notices*.—The posting of decisions and instructions on the Official Notice Board on and after September 9, 1926, constitutes an official notification to all competitors, who are responsible for acquainting themselves with such decisions and instructions.

16. *Entries*.—The entry fee is £10. This fee, together with the entry form, must be received by the Royal Aero Club not later than June 30, 1926. Late entries will be received up to 12 noon on July 31, 1926. Late entry fee, £30.

The Royal Aero Club, in the interests of safety, reserves the right to refuse any entries and/or prohibit the flight in the competition of any competitor if it considers the flight would be dangerous.

17. ELIMINATING TESTS

The following eliminating tests A, B, C, and D must be carried out in this order and must be passed to the satisfaction of the officials before taking part in the competition proper.

Aeroplanes must be presented to the officials, fully erected, for the eliminating tests at 10 a.m. on Friday, September 10, 1926. Aeroplanes not so presented will be debarred from taking part in the competition.

The eliminating tests will commence at 10 a.m. on Friday, September 10, 1926, and will be continued on the following day. These tests must be completed by 8 p.m. on Saturday, September 11, 1926. Aeroplanes not having done so will be debarred from taking part in the competition.

A. *Dismantling, Housing, and Re-erecting*.—For this test the aeroplane must be presented to the officials fully erected.

It must then be dismantled or folded in such a manner as to permit of its being completely transported in one journey without the use of any extraneous tackle, over a distance of not more than 25 yards, and placed in a shed 10 ft. in width and 10 ft. in height. It must then be taken outside the shed and re-erected.

Two persons only will be allowed to handle the aeroplane throughout this test, and the time occupied must not exceed one hour.

No special devices will be allowed unless carried as part of the equipment of the aeroplane in flight during the competition. Such equipment will not be weighed or considered as part of the useful load.

B.—*Demonstration of Dual Control*.—This test will consist of two separate flights of not less than five minutes' duration each, within sight of the aerodrome, at the termination of each of which one figure of eight must be flown within the boundary of the aerodrome.

The pilot must be alone and occupy alternately the two seats in the aeroplane.

C.—*Getting Off*.—This test will consist of a take off, starting from rest and flying in a straight line over two barriers 25 ft. high and placed 25 yards apart. The distance from the starting pont to the first barrier will be 300 yards. This distance is based on a wind not exceeding 6 miles per hour.

The wheels of the aeroplane will be placed on the starting line. The start will be a standing one. No assistance, launching devices or chocks will be permitted for the actual getting off.

D.—*Pulling Up*.—This test will consist of a straight landing over a barrier 6 feet high. The length of run must not exceed 125 yards. This distance is based on a wind not exceeding 6 miles per hour.

The engine may be shut off before crossing the barrier.

Any form of braking device may be used, provided it is carried throughout the Competition.

The distance will be measured from the centre of the barrier in a straight line to the farthest point of contact of the aeroplane with the ground. Only normal straight landings will be measured. In the event of damage to the aeroplane which in the opinion of the stewards would prevent further flight, the attempt would not count.

Eliminating Tests C and D must be performed with the total load which the machine is to carry throughout the competition.

In the case of failure to carry out tests C and D with the load anticipated, the load may be reduced to a figure not less than 340 lbs., but the load at which the machine finally passes the tests shall be deemed to be the maximum load carried for the purposes of the Competition.

All competitors will be allowed a number of attempts in these tests, but any Competitor failing to start within five minutes of his allotted starting time will not be allowed to start and this will count as an attempt. Additional attempts will be allowed in the same order as time permits.

18. COMPETITION

The competition will be over courses totalling approximately 2,000 miles. The total distance must be flown at an average speed of not less than 50 m.p.h.

The following are the courses :—

Sunday, September 12, 1926.—Lympne to Brighton and back, 106 miles. This circuit must be covered three times and alightings made at Lympne Aerodrome on the completion of each circuit. *Total for day* .. .. 318 miles.

Monday, September 13, 1926.—Lympne, Eastbourne, Lympne, Hastings, Lympne, 124 miles. This circuit must be covered three times and alightings made at Lympne Aerodrome on the completion of each circuit. *Total for day*.. 372 ,,

Tuesday, September 14, 1926.—Lympne, Dover, Ramsgate, Margate, Herne Bay, Lympne, 62 miles. This circuit must be covered six times and alightings made at Lympne Aerodrome on the completion of each circuit. *Total for day*.. 372 miles

Wednesday, September 15, 1926.—Lympne to Brighton and back, 106 miles. This circuit must be covered three times and alightings made at Lympne Aerodrome on the completion of each circuit. *Total for day*. .. .. 318 ,,

Thursday, September 16, 1926.—Lympne, Dover, Ramsgate, Margate, Herne Bay, Lympne, 62 miles. This circuit must be covered six times and alightings made at Lympne Aerodrome on the completion of each circuit. *Total for day* 372 ,,

Friday, September 17, 1926.—Lympne to Croydon and back, 106 miles. This circuit must be covered twice and alightings made at Lympne Aerodrome on the completion of each circuit. *Total for day* .. .. 212 ,,

Total .. .. .. 1,964 ,,

The turning points on the courses will be announced later.

Each course must be completed on the day allotted for that particular course between the hours of 8 a.m. and 8 p.m. Any Competitor failing to complete the Course within the specified time and date will be eliminated from the Competition.

PRIZES

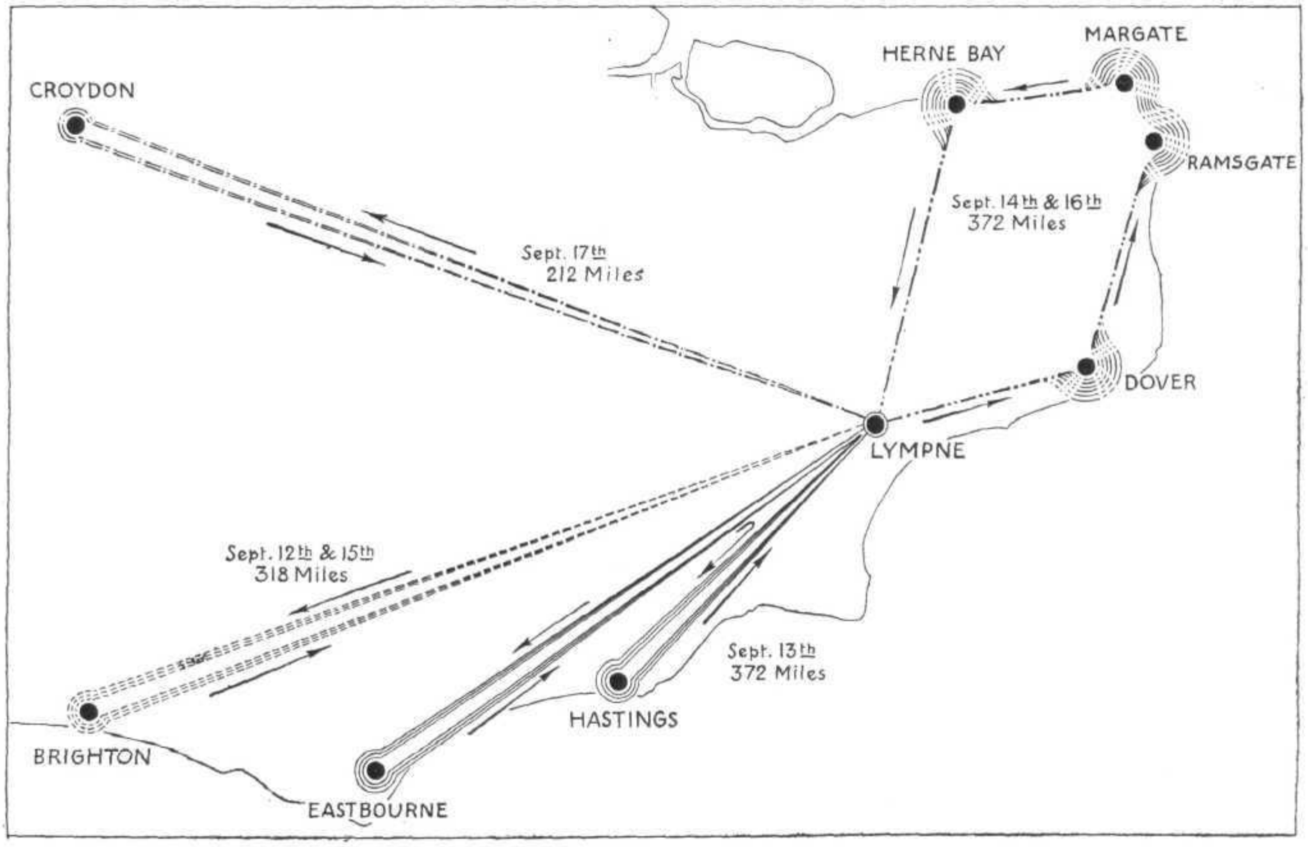
The *First Prize of* £3,000 will be awarded to the entrant of the aeroplane which having complied with all the requirements laid down carries the greatest useful load per unit of fuel consumed.

The useful load is 340 lbs., which includes the weight of the pilot and passenger (if carried), plus any ballast carried as further load, up to the weight specified by the Certificate of Airworthiness.

The *Second Prize of* £1,500 and the *Third Prize of* £500 will be awarded respectively to the entrants of the aeroplanes which are placed second and third.

S.M.M.T. Prize, 200 Guineas

At the conclusion of the competition a race on handicap will be held over a course of approximately 100 miles. This race will be open to the aeroplanes taking part in the Light Aeroplane Competition which shall have accomplished at least 50 per cent. of the course in the competition.



SKETCH MAP OE THE COURSE FOR THE LYMPNE COMPETITION: The number of circles at the turning points indicates how many times the particular circuit must be covered, and the mileages marked refer to the total distance of each circuit.

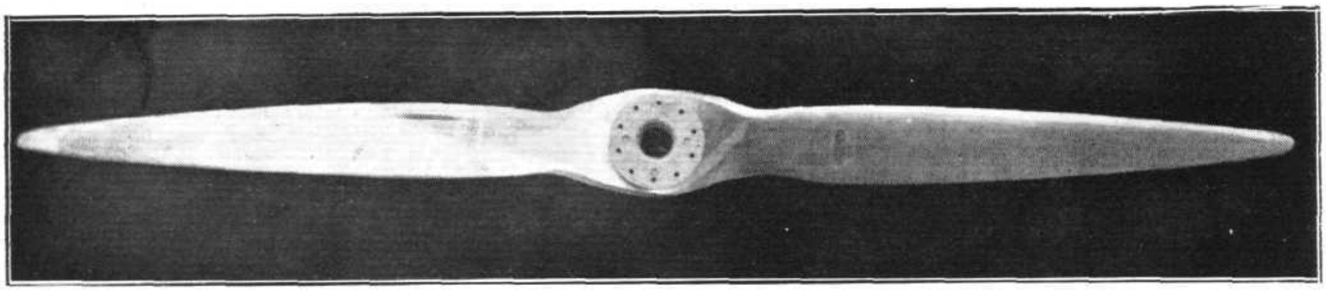
METAL AIRSCREWS

Comparative Flying Tests of Fairey-Reed on D.H. 9

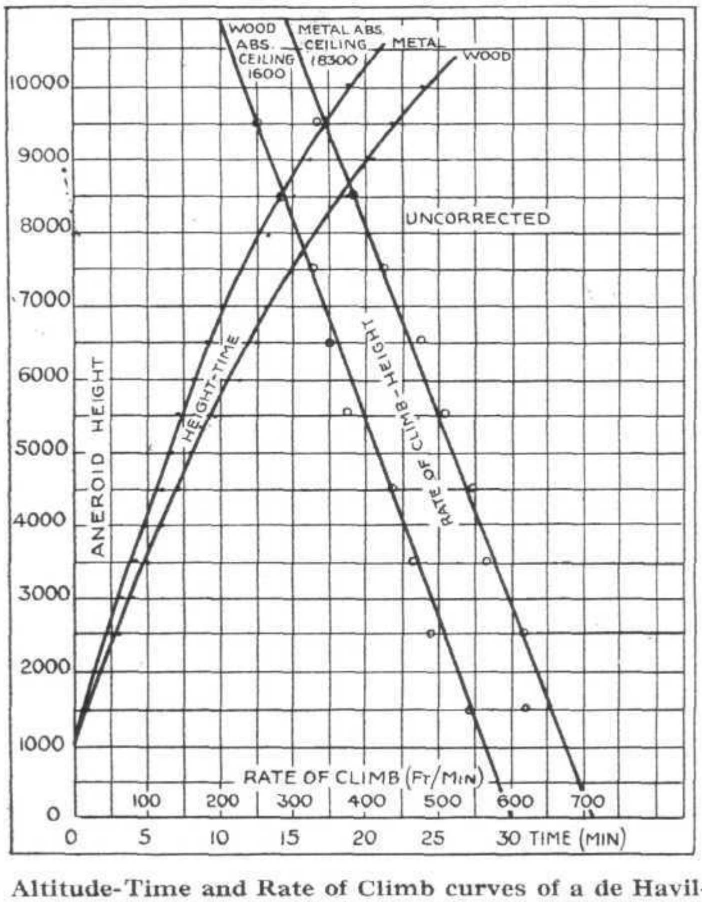
THE subject of metal airscrews is one coming increasingly to the front, and whatever form the propeller of the future may take, it is scarcely to be doubted that, like the aircraft itself, it will ultimately be constructed of metal. Already there are a number of types of metal airscrews on the market and in regular use, although it could hardly be claimed that the metal airscrew has so far supplanted our well-tried friend the laminated wood airscrew. Under certain conditions there can be no doubt that the metal airscrew scores, and it is therefore of considerable interest to examine any data that become available concerning this type of propeller. Such an opportunity occurred recently in the case of a De Havilland aeroplane, and by arrangement with the Fairey Aviation Company a series of comparative tests were carried out with a standard airscrew and a Fairey-Reed Duralumin propeller, fitted on the Siddeley "Puma" engine of a D.H. 9. The flight tests were carried out on the same day—in fact, during the same morning, so that the conditions were identical as regards the flight with the standard airscrew and that with the Fairey-Reed.

The weight empty of the D.H. 9 used in the tests, G-EBGT, was 2,428 lbs., and the load was made up as follows: fuel and oil (full tanks), 660 lbs.; pilot, 140 lbs.; observer, 180 lbs.; total loaded weight, 3,410 lbs.

The comparative results are shown on the accompanying graph, and certain further particulars are given in the following tables. From these it will be seen that the Fairey-Reed Duralumin airscrew gave a marked increase in performance, both as regards climb and speed. The figures of the results, it should be pointed out, have not been corrected, so that as performance figures they may not be quite accurate, although for comparative purposes this should not matter.



A Fairey-Reed Duralumin Airscrew.



Altitude-Time and Rate of Climb curves of a de Havilland 9 aeroplane as fitted with normal propeller and Fairey-Reed airscrew.

Climb

Aneroid Height.	Time. Wood.		Time. Metal.		Temp °C. Wood and Metal.	R.p.m. Wood.	R.p.m. Metal.
	M.	s.	M.	s.			
+100 (GL)	—		—		+12	1,240	1,240
1,000	0		0		9	1,300	1,310
1,500	1	01	0	54	8	1,310	1,310
2,000	1	56	1	43	6	1,300	1,330
2,500	2	56	2	42	4½	1,300	1,320
3,000	3	52	3	29	3	1,300	1,310
3,500	4	42	4	16	2	1,300	—
4,000	5	50	5	04	1	1,300	—
4,500	6	51	5	49	0	1,300	1,320
5,000	8	03	6	37	—½	1,300	—
5,500	9	44	7	26	—1	1,300	1,320
6,000	11	11	8	14	—2	1,300	1,310
6,500	12	35	9	15	—2½	1,300	1,310
7,000	13	37	10	24	—3	1,300	1,320
7,500	15	06	11	39	—4	1,300	1,320
8,000	16	44	13	32	—5	1,300	1,310
8,500	18	35	15	01	—5½	1,310	1,320
9,000	20	34	16	01	—6½	1,310	1,320
9,500	22	15	17	43	—7½	1,300	1,310
10,000	24	16	19	12	—9½	1,300	—

Level Speeds

Height (Standard).	True Speed, m.p.h. Wood.	True Speed, m.p.h. Metal.	R.p.m. Wood.	R.p.m. Metal.
Ft.				
10,200	95·0	98·5	1,360	1,360
6,400	103·0	108·0	1,400	1,400
5,000	105·0	108·0	1,410	1,410
3,000	107·0	109·0	1,410	1,420
G.L.	112·0	116·0	1,450	1,450

The AIRCRAFT ENGINEER

FLIGHT ENGINEERING SECTION

Edited by C. M. POULSEN

April 29, 1926

CONTENTS

OUR CONTRIBUTORS

Captain F. S. Barnwell, chief designer and engineer to the Bristol Aeroplane Co., Ltd., may be regarded as one of the pioneers among British aircraft designers, having been actively engaged upon aeroplane design since about 1908, when, with his brother, the late Mr. Harold Barnwell, he designed and built his first machine, a monoplane which was characterized by having no top bracing. Captain Barnwell has spent nearly the whole of his aeronautical career with the Bristol firm, with the exception of an absence of about two years spent in Australia as Officer-in-Charge of Design in the Royal Australian Air Force. During his stay in Australia Captain Barnwell devoted a good deal of time to an attempt to put into simple form the question of the stability of an aeroplane, and since his return to the Bristol Company he has been hard at work on the subject. We are naturally very gratified that Captain Barnwell, who, it will be realised, is a very busy man, should have consented to give readers of The Aircraft Engineer the benefit of his extensive work in this direction by allowing us to publish, for the first time, the methods which he has evolved.

Captain Barnwell's article is a somewhat lengthy one—unfortunately from the Editor's point of view—so that it has been necessary to divide it into two instalments, as it was felt that this would be preferable to attempting to cut down the size of the article and thus run the risk of detracting from its value.

Mr. J. D. North continues his series of articles on Aeroplane Performance by writing on the subject of wing proportions in the light of the vortex theory, and as this is a subject coming very much to the front just now, and one which has not, perhaps, received in this country the attention that it merits, we are sure our readers will find much food for thought in this article.

Dr. Leslie Aitchison, whose previous article on Duralumin has been so much appreciated, continues in this issue with a further instalment dealing mainly with the subjects of heat treatment, quenching, annealing, and ageing, and he recommends that where possible the material should be worked immediately after quenching, say within an hour or two, before the ageing process has had time to change the metal from the soft state in which it is found after quenching.

A SUGGESTED METHOD FOR ATTAINING STABILITY IN THE ORIGINAL LAY-OUT OF AN AEROPLANE DESIGN.

By F. S. Barnwell.

The stability of an aeroplane is necessarily a subject of considerable complexity for mathematical treatment, and it is improbable that the methods, more or less "standardised" by this time, are capable of much further simplification—at any rate without risk of serious inaccuracy. I do not propose to attempt criticism or "improvement" of the mathematical treatment of stability, but give particulars of an empirical procedure, based on analogy, whereby it is suggested that in the original lay-out for a new aeroplane a degree of stability may be assured approximately the same as that of some existing aeroplane.

By "stability" is meant "inherent stability" in the ordinarily accepted sense, hence by a "stable" aeroplane is meant :—

(*a*) An aeroplane which, with any chosen setting of its tail-plane and with all its controlling surfaces held in their "neutral" positions, maintains a constant "natural" attitude to its flight-path and in consequence possesses a constant "natural" flight-speed (relative of course to the surrounding air) for any particular value of ρ (the density of the air surrounding it).

The flight-path is rectilinear but not necessarily horizontal : for if the air-screw thrust be greater than that required for horizontal flight at the "natural" speed, the machine will "climb," whilst if this thrust be less, the flight path will be inclined downwards less or more—the downward limit being the "natural gliding angle" taken up when the engine is stopped.

(*b*) An aeroplane which, if subjected to some disturbance (as, say, a variation in velocity or direction of the wind, or a temporary displacement from "neutrality" of a controlling surface) which alters its "natural" attitude to its flight-path, tends, immediately such disturbance ceases, to revert more or less rapidly to its "natural" attitude to a rectilinear flight-path ; the orientation of the flight-path after such disturbance may not however be the same as it was before the disturbance.

It is comparatively safe to consider separately "stability in pitching" (or "longitudinal" stability) and "lateral stability" ; but "lateral stability" *includes* both "stability in rolling" (sometimes inaccurately termed "lateral stability") and "stability in yawing" (also dubbed "directional" or "weather-cock" stability), for these two types of motion are interdependent and *cannot be considered separately.*

Stability in Pitching.

The air screw, body and wings of an aeroplane are generally "instable" in pitching and to attain stability the requisite area of tail-surface must be provided.

It is necessary in the first place that, at any attitude of pitch, a small *alteration* of angle of pitch causes an increment of "stable" pitching moment due to the tail surface *greater than* the sum of the increments of "instable" pitching-moments due to air-screw, body and wings; it is necessary

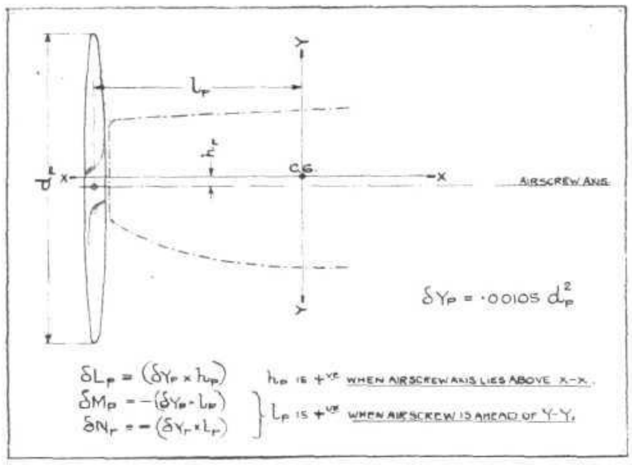


Fig. 1.—Values for lateral force and moments due to airscrew.

as well that this excess of "stable" moment be sufficiently great to ensure reasonably rapid damping of the pitching (or "phugoidal") oscillations.

In Fig. 1 is given an empirical equation for determining δM_P, the coefficient of *alteration* of pitching moment due to airscrew per 1° *alteration* of angle of pitch.

In Fig. 2 is given an empirical equation for determining δM_B, the coefficient of alteration of pitching moment due to body per 1° alteration of angle of pitch.

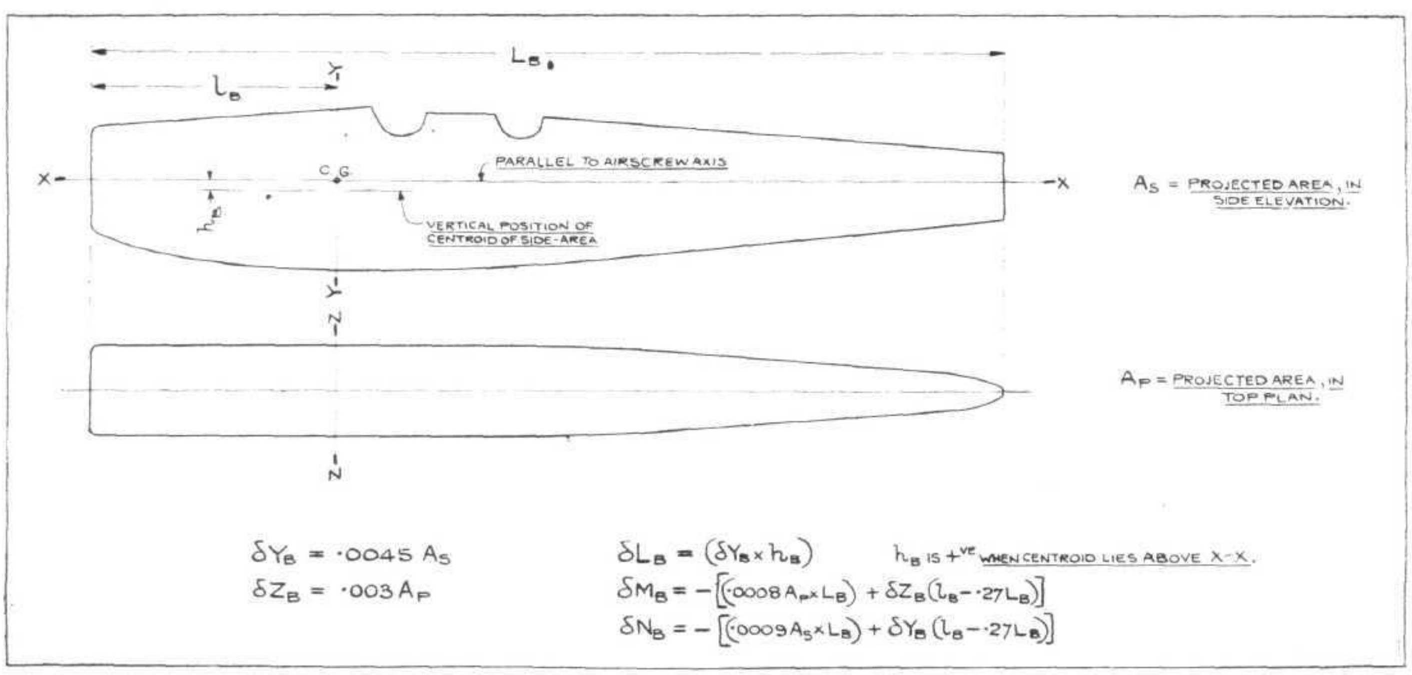


Fig. 2.—Values for forces and moments due to body.

In Fig. 5 an empirical equation for determining δM_T, similar coefficient due to tail-surface.

In Fig. 6 one for determining δM_W, similar coefficient due to wing surface.

In explanation of these figures:—

All linear dimensions are to be taken in feet, all areas in square feet, all angles in degrees. X-X, Y-Y and Z-Z are assumed to be the three main axes of the aeroplane and are fixed with respect to the aeroplane; X-X (the rolling axis) is taken as parallel to the airscrew axis, Y-Y (the yawing axis), and Z-Z (the pitching axis) are both at right angles to axis X-X, but axis Y-Y lies in the central plane-of-symmetry of the aeroplane whilst axis Z-Z is at right angles to this plane.

All the values for forces are expressed in the form of coefficients, δY being a coefficient of lateral force (*i.e.*, force in direction of axis Z-Z), δZ being a coefficient of normal force

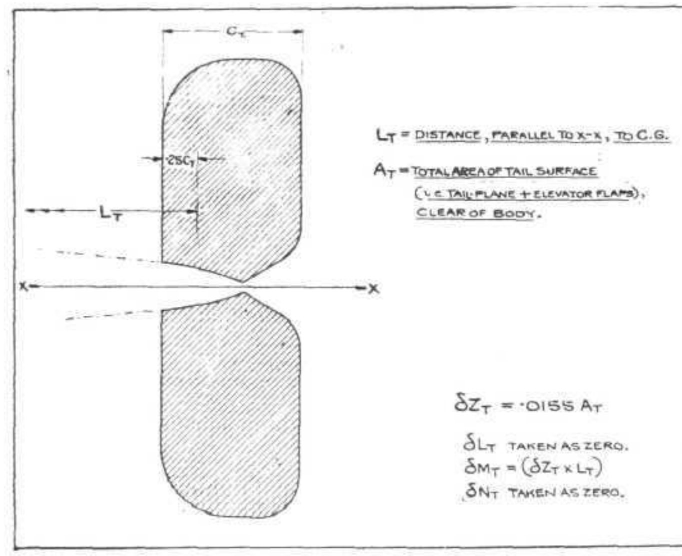


Fig. 5.—Values for vertical force and moments due to tail surface.

(*i.e.*, force in direction of axis Y-Y). The coefficients of lateral force are values of:—

(Lateral force in lbs.) $\div\ \beta \rho v^2$

The coefficients of normal force are values of:—

(Normal force in lbs.) $\div\ a\rho v^2$

similarly all the values for moments are expressed in the form of coefficients, δL being a coefficient of rolling-moment, δM a coefficient of pitching-moment and δN of yawing-moment.

The coefficients of rolling-moment are values of:—

(Rolling-moment in foot lbs.) $\div\ \beta \rho v^2$

The coefficients of pitching-moment are values of:—

(Pitching-moment in foot lbs.) $\div\ a\rho v^2$

The coefficients of yawing-moment are values of:—

(Yawing-moment in foot lbs.) $\div\ \beta \rho v^2$

β = angle of yaw, of axis X-X to flight-path, in degrees.

a = *alteration* of angle of pitch, in degrees.
ρ = density of air in slugs.
v = speed, along flight path, in feet per second.

The small suffix letters tagged on to all the coefficient symbols serve to indicate the element of the aeroplane to which they are due.

A *negative* sign for a moment-coefficient indicates that the moment is an "*instable*" one, a positive sign (or no sign) that the moment is a "stable" one; an "*instable*" moment of pitch or of yaw is one which tends to increase the divergence from the initial attitude, an "*instable*" moment of roll is one which tends to depress the port wing tip when the tail of the machine is yawed to port; "stable" moments are, of course, those which produce the opposite effects.

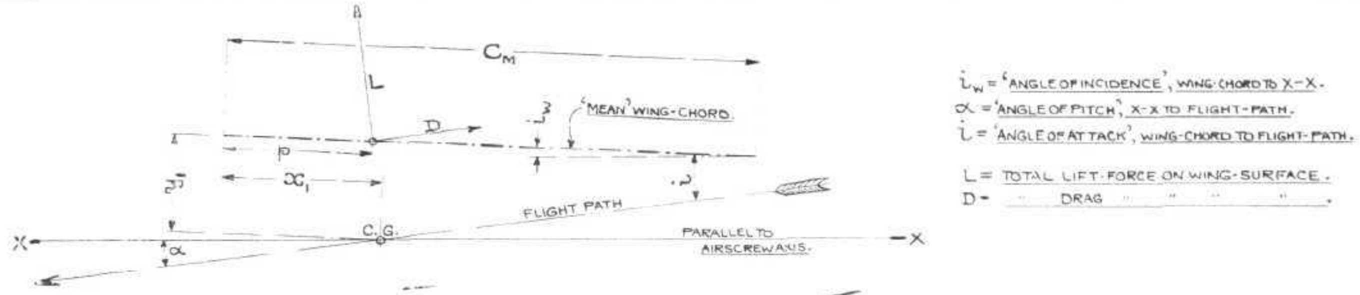
To revert then to stability in pitching :—Having calculated the values of δM_P, δM_B and δM_W for the design under examination, it remains to give such area to the tail surface that :—

$$\delta M_T = -C_1(\delta M_P + \delta M_B + \delta M_W) \quad \ldots\ldots\ldots\ldots (1)$$

C_1, the empirical "measure" of stability in pitching, should

The rate of change of pitching moment due to wings is smaller the farther forward the C.G., and (though to a considerably lesser degree) is smaller the greater the distance of the C.G. below the "mean" chord; or, expressed in the symbols of Fig. 6 the smaller the value of $\frac{x_1}{C_M}$ the smaller will be the value of δM_W, and the greater the value of $\frac{y_1}{C_M}$ the smaller will be the value of δM_M, and vice-versa. Neglecting the effect of variation of $\frac{y_1}{C_M}$ as of secondary importance within the usual limits of its variation and assuming, for simplicity, that $y_1 = 0$ (*i.e.*, that C.G. lies on "mean" chord), for a wing of R.A.F. 15 section :—

When $x_1 = 0{\cdot}27\ C_M$ $\quad [\delta M_W \div (A_W \times C_M)] = 0{\cdot}0014$
,, $\quad = 0{\cdot}30\ C_M$ $\quad [\delta M_W \div (A_W \times C_M)] = 0{\cdot}00255$
,, $\quad = 0{\cdot}33\ C_M$ $\quad [\delta M_W \div (A_W \times C_M)] = 0{\cdot}0037$



$$M_W = \left[K_L\left(\frac{x_1 - P}{C_M}\cos i - \frac{y_1}{C_M}\sin i\right) + K_D\left(\frac{x_1 - P}{C_M}\sin i + \frac{y_1}{C_M}\cos i\right)\right] \times A_W \times C_M \times \rho v^2$$

(y_1 IS +VE WHEN C_M IS ABOVE C.G.)

IF S_W = 'EQUIVALENT MEAN SPAN' OF WINGS & γ = DIHEDRAL ANGLE :—

$$\delta Y_W = (\cdot 00007 + \cdot 00006\gamma)A_W$$

$$\delta L_W = [(\cdot 00007 + \cdot 00013\gamma) \times A_W \times S_W] + [\delta Y_W \times y_1]$$

(y_1 IS +VE WHEN C_M IS ABOVE C.G)

$$\delta M_W = (\text{MAXIMUM VALUE FOR } M_W \text{ PER } 1^\circ \text{ ALTERATION OF ANGLE OF PITCH}) \div \rho v^2$$

$$\delta N_W = \cdot[\cdot 000028(1 - \cdot 5\gamma) \times A_W \times S_W]$$

Fig. 6.—Values for lateral force and moments due to wing surface.

have some value between $1{\cdot}5$ and $3{\cdot}5$ depending upon the degree of stability required.

For the same degree of stability, however, the value of C_1 is dependent to some extent upon the pitching moment of inertia (moment of inertia about axis Z-Z) of the aeroplane and upon the location of the C.G. with respect to the "mean" wing chord (*apart from the effect of this relation upon* δM_W).

It is probable that the former factor may be neglected in this empirical procedure, unless one has reason to suppose that the length of the radius of gyration in pitch is of abnormal value compared to, say, the length of the "tail-lever" (L_T in Fig. 5). It would appear reasonable to expect that, for the same degree of stability, the value of C_1 should vary linearly as does the value $\frac{k_P}{L_T}$

k_P being the radius of gyration in pitch. Now for the "Bristol Fighter"

$$\frac{k_P}{L_T} = \frac{4{\cdot}56}{15{\cdot}84} \doteq 0{\cdot}29.$$

Hence we might say that, assuming one has calculated the values for the radii of gyration (a simple but tedious business). C_1 should have some value between $5{\cdot}0\ \frac{k_P}{L_T}$ and $12{\cdot}0\ \frac{k_T}{L_T}$ depending upon the degree of stability required.

As regards effect of location of C.G. with respect to "mean" wing chord :—

Assuming that for the case $x_1 = 0{\cdot}27\ C_M$ the value of $[\delta M_P + \delta M_B]$ be $0{\cdot}5$ of the value of δM_W it follows that, if x_1 be the only variable, when

$x_1 = 0{\cdot}27\ C_M$ $\quad [\delta M_P + \delta M_B + \delta M_W] = 0{\cdot}0021\ (A_W \times C_M)$
,, $\quad = 0{\cdot}30\ C_M$ $\quad [\delta M_P + \delta M_B + \delta M_W] = 0{\cdot}00325(A_W \times C_M)$
,, $\quad = 0{\cdot}33\ C_M$ $\quad [\delta M_P + \delta M_B + \delta M_W] = 0{\cdot}0044\ (A_W \times C_M)$

In other words, if nothing except x_1 be varied, an aeroplane with $x_1 = 0{\cdot}30 C_M$ would need about $1{\cdot}55$ times the tail area that it would if $x_1 = 0{\cdot}27\ C_M$, whilst with $x_1 = 0{\cdot}33\ C_M$ it would need about $2{\cdot}10$ times the tail area that it would if $x_1 = 0{\cdot}27\ C_M$ and about $1{\cdot}35$ times the tail area it would if $x_1 = 0{\cdot}30\ C_M$, in order to retain the same value for C_1.

Now the equation of motion in pitching is of the form

$$I_Z \frac{d^2\alpha}{dt^2} + M\alpha + M_P \frac{d\alpha}{dt} = 0 \quad \ldots\ldots\ldots\ldots (2)$$

In which I_Z = Moment of inertia about axis Z-Z.
M = Pitching-moment, assumed to vary linearly as α the angle of pitch.
M_P = "Damping factor" or pitching-moment due to rate of pitching; this factor is due almost wholly to the tail surface.

I_Z is constant, for an aeroplane in which x_1 and area of tail are the only variables, hence, if the area of the tail-surface were increased so as to retain (in equation (1)) the same value for C_1 as x_1 is increased, *both* M and M_P (in equation (2)) would be increased; this means that the amplitude of pitch

would be somewhat decreased, *i.e.*, the stability in pitching would be somewhat higher. This indicates that the value for C_1 might be somewhat *decreased* as x_1 is *increased*, to retain the same degree of stability, but the amount by which it might be decreased needs further investigation. I would merely suggest tentatively that, taking $x_1 = 0{\cdot}30$ as a "starting point," the value of C_1 might be *reduced* by the same percentage that the value of x_1 is *increased*, and *vice-versa*.

Before leaving the subject of stability in pitching it is advisable to enlarge a little concerning the pitching-moments due to the wings and to the tail surface. In Fig. 6, M_W is pitching moment due to wings in foot-lbs., A_W being the total area of wing surface in square feet and C_M the "mean" chord length of the total wing surface in feet. In the equation for M_W, in this figure, the expression

$$\left[K_L\left(\frac{x_1-P}{C_M}\cos i-\frac{y_1}{C_M}\sin i\right)+K_D\left(\frac{x_1-P}{C_M}\sin i+\frac{y_1}{C_M}\cos i\right)\right]$$

is usually denoted by Q, whilst ($A_W \times C_M$) is usually called the "wing volume" and denoted by U. To determine δM_W it is necessary to calculate, from data for the particular wing form, the values of Q for a series of values of i; say, for every degree, from $i = -3°$ to $i = +10°$. Probably, by inspection, one may then decide upon the greatest *difference* for Q per 1° *alteration* of i; but, if the point be at all doubtful, it is advisable to run a curve of value of Q on a base of value of i and the tangent to this curve making the largest angle with the base line will give a measure of the maximum value for $\frac{dQ}{di}$.

For a monoplane the "mean" chord may be determined by some approximate method as that given in Fig. 7; the "mean" chord for each surface (upper and lower) of a biplane may be separately determined in the same way and thence, by some method as that given in Fig. 8, may be determined the total "mean" chord for the complete biplane.

In Fig. 5, the empirical value given for δZ_T is fairly accurate for a tail surface of "symmetrical" section, of aspect ratio about $3{\cdot}5$, when L_T is of "normal" value (say, equal at least to $2{\cdot}5$ times the "mean" chord length of the wings). The value for δZ_T would naturally be lower for a tail surface of lower aspect ratio, and/or for a shorter "tail lever" length.

(To be continued.)

AIRCRAFT PERFORMANCE.

Wing Proportions in the Light of the Vortex Theory.

By J. D. NORTH, F.R.Ae.Soc.

(Continued from page 30.)

Accepting the idea that the lift properties of an aerofoil can be referred to the curvature of its centre line, we can conceive a wing section as a streamline form having its centre line bent to the form of a circular arc. Two simple consequences follow. The lift coefficient at zero incidence in two-dimensional motion will be that corresponding to the centre-line curvature, and the minimum drag of the streamline form (*i.e.*, profile drag) will occur at this value of k_L. If we decide at what values of k_L we are to operate, we can find what curvature to give to the wing. For example referring to Figs. 1 and 2 (see THE AIRCRAFT ENGINEER February 25), we find that 125 m.p.h. at 15,000 ft., with a wing loading of 10 lb. per square foot, corresponds to $k_L = 0{\cdot}2$, and consequently, if we curve the wing as indicated in Fig. 7 (see THE AIRCRAFT ENGINEER, March 25), and if we use the thinnest streamline section to contain our structure, *we shall have done all which can be done by choice of wing section to keep down wing drag* under that particular operational condition. The arbitrary choice of 10 lb. per square foot implies a certain maximum lift coefficient if stalling speed is a criterion of loading, and if the profile drag coefficient (k_{D_∞}, *i.e.*, k_D for infinite span) is unaltered by change of chord, the minimum value of absolute drag will be given by the section which has a minimum value of k_{D_∞}/k_L max. It is obvious that the containing of the structure necessitates an increase of thickness with decrease of chord with a consequent rise of k_{D_∞} for all practical thicknesses; so the influence of k_L max. is limited—an important fact to which we shall have to return later.

So long as the span was infinite, the load grading along the span was rectilinear. When the span is finite, the "end effect" changes the load grading, which becomes nearly elliptical as in Fig. 8.

When the span is finite, the air no longer flows straight across the wing parallel to the direction of motion, but inwards *towards* the centre on the top of the wing, and outwards *from* the centre at the bottom of the wing as in Fig. 9. The relative motion of the air from the top of the wing and the air from the bottom gives rise to a vortex sheet as indicated in the figure, and the sheet rolls up into two trailing vortices. The energy in this vortex system has to be paid for, and its price is extra drag. Alternatively, it may be imagined that the vortex system distorts the airstream so as to cause a virtual down-current on the wing, the "lift" being inclined backwards in consequence. The horizontal component of the backwardly-inclined lift is called induced drag, and *the absolute value of the induced drag is a function of the span, weight and indicated airspeed only*; it is entirely independent of wing section or aspect ratio. This is true for monoplanes and for multiplane systems, except that in the case of the latter it is a function also of the gap/span ratio. The values of induced drag (monoplane) expressed as a ratio to lift are given in Fig. 10 at various indicated airspeeds and values of Span²/weight for elliptical distribution.

The corresponding formula is:

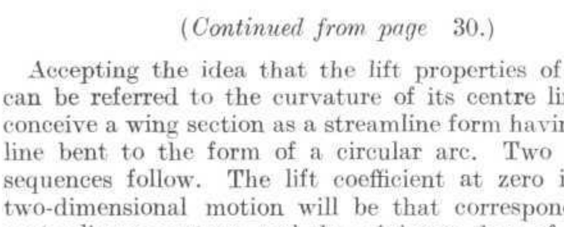
$$\frac{\text{Lift}}{\text{Induced drag}} = 0{\cdot}008\,\frac{\text{Span}^2}{\text{W}} \times V_i^2,$$ where V_i is the I.A.S. in m.p.h.

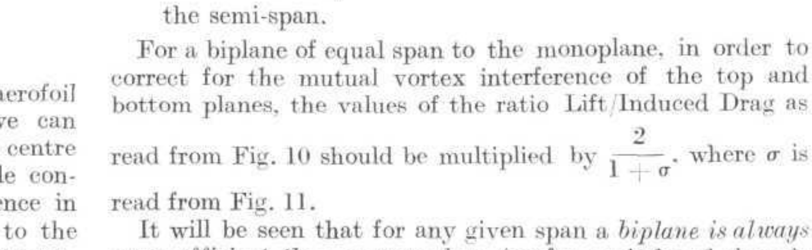
For the induced drag coefficient k_{D_1}, we have

$$k_{D_1} = \frac{2}{\pi}\ \frac{S}{4s^2}\,k_L^2,$$ where S is the wing area and s is the semi-span.

For a biplane of equal span to the monoplane, in order to correct for the mutual vortex interference of the top and bottom planes, the values of the ratio Lift/Induced Drag as read from Fig. 10 should be multiplied by $\frac{2}{1+\sigma}$, where σ is read from Fig. 11.

It will be seen that for any given span a *biplane is always more efficient than a monoplane* (so far as induced drag is concerned), and the gap effect is not a function of the chord or the wing section, but of the span (subject naturally to appropriate allowances for *décalage* or chord inequality). There are plainly some practical limitations to gap/chord ratio for which I would suggest the term profile drag inter-





Figs. 8 and 9

ference, since even with aerofoils of infinite span the gap/chord cannot be reduced indefinitely without some disturbance of the flow. I do not know of any direct evidence on this point, but some experiments carried out by Boulton & Paul on the interference of two streamline struts at zero incidence have a bearing on this matter. The results of these tests are shown in Fig. 12. From this it would appear that profile drag interference is negligible when the gap is ten times the thickness of the strut. Applying this to wings of thickness one-tenth of the chord, we may say that with a gap/chord ratio of 1, such interference, near minimum profile drag at least, is avoided.

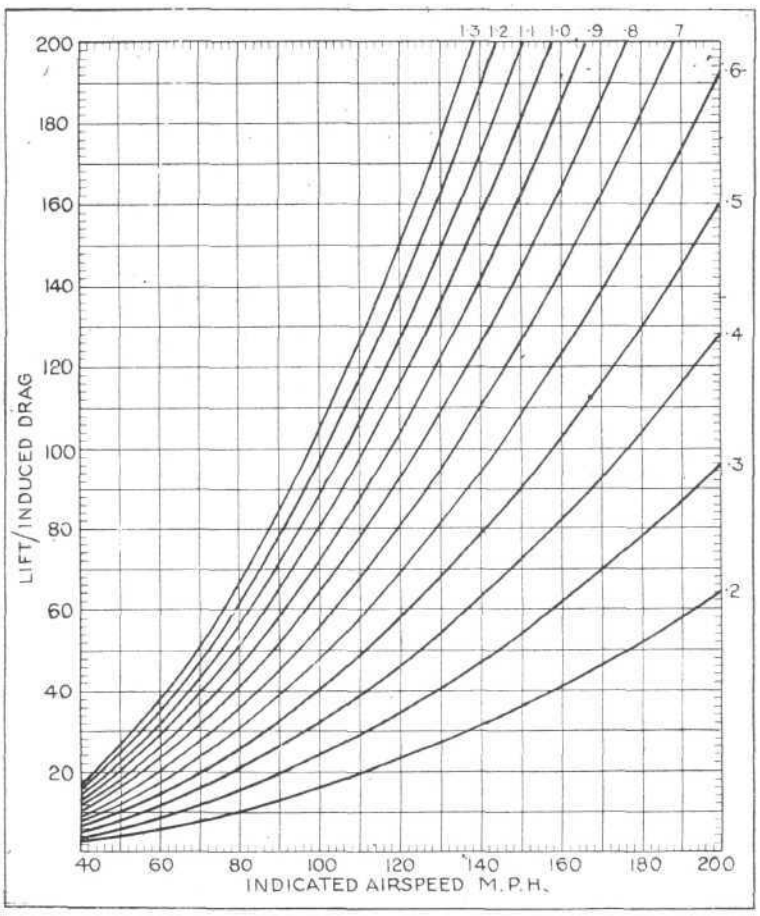
The vortex theory indicates no difference between the loads carried by the upper and lower wings. Wind channel tests on a R.A.F. 15 biplane show a distribution as follows :—

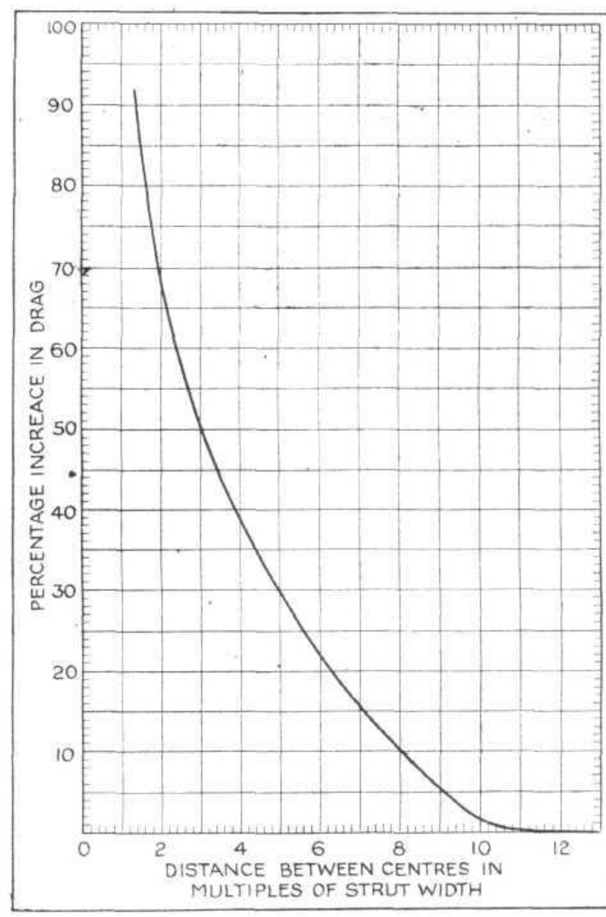
	Incidence (Degrees).							
	0	2	4	6	8	10	12	14
*Upper Wing k_L	·085	·140	·210	·275	·335	·405	·480	·555
Lower Wing k_L	·090	·140	·210	·265	·325	·380	·430	·505

current " increasing in inclination from the centre outwards, so that the outer sections are working at a smaller " incidence "† than those in the centre. Consequently, as the centre of the wing stalls first, there is some loss in maximum lift coefficient as against the elliptical plan form. None of these differences is great, and the nett effect on induced drag of " fancy " plan forms, washouts and end panels (á la Voisin) is therefore very small, while some of these plan forms may be favourable on poor sections with an *adverse* effect on maximum lift with good sections.‡

Variation of Span²/W has a preponderating effect on induced drag, and attention is drawn to the gap influence being relatively small. It is possible that " fancy " end shapes may have some effect on profile drag, and be important for racing machines. No reliable full scale evidence is available.

The small influence of plan form on distribution has an important bearing on tapered wings, whose properties are very far removed from those calculated from integration making lift proportional to chord. The old conception of a " geometric mean chord " ceases in consequence to have any real significance.





Figs. 10 and 12

As the minimum profile drag of R.A.F. 15 occurs in the neighbourhood of $k_L = \cdot 15$, it may be that the disparity in lift distribution is due to profile drag interference becoming important as the flow becomes less streamline.

We have so far assumed elliptical distribution along the span; in fact, such distribution, which gives the lowest profile drag, is obtained with an elliptical form. The difference in distribution between angular and elliptical plan forms is not large, and the correction of induced drag for a non-elliptical wing may be obtained from the formulæ of Betz., given in R. & M. 767, from which it may be seen that the correction depends on aspect ratio and $\frac{dk_L}{d\alpha}$. For an aspect ratio of 6, the average correction is an increase of 5 per cent. for the rectangular wing. The approximation of the rectangular plan form distribution to an ellipse is due to the " down

* ref. R. & M. 774, 857.

We may review the position by an example of the performance of a streamline form with different centre line curvatures. Take, for example, the three forms of the R.A.F. 30 series, details of which are published in R. & M. 928. These are convenient as the reader may refer to the publication for more details, and because the series has been conducted systematically. Similar examples may be found by the interested if they explore published wind channel data, *e.g.*,

" Ergebnisse der Aerodynamischen Versuchamstalt zu Göttingen."

The streamline section (R.A.F.30) is constructed by the transformation given in R. and M. 911 for a Joukowski aerofoil, using the constants $k = 1 \cdot 08$, $n = 1 \cdot 95$, $\beta = 0$. Two further sections are then obtained by bending the section to cambers $0 \cdot 02$ (R.A.F. 31) and ·05 (R.A.F. 32), corresponding to $k_L = \cdot 13$ and $k_L = \cdot 31$ respectively. I have plotted the

† Caveat. " Incidence " here means incidence to the relative wind.
‡ B. & P. Unpublished tests.

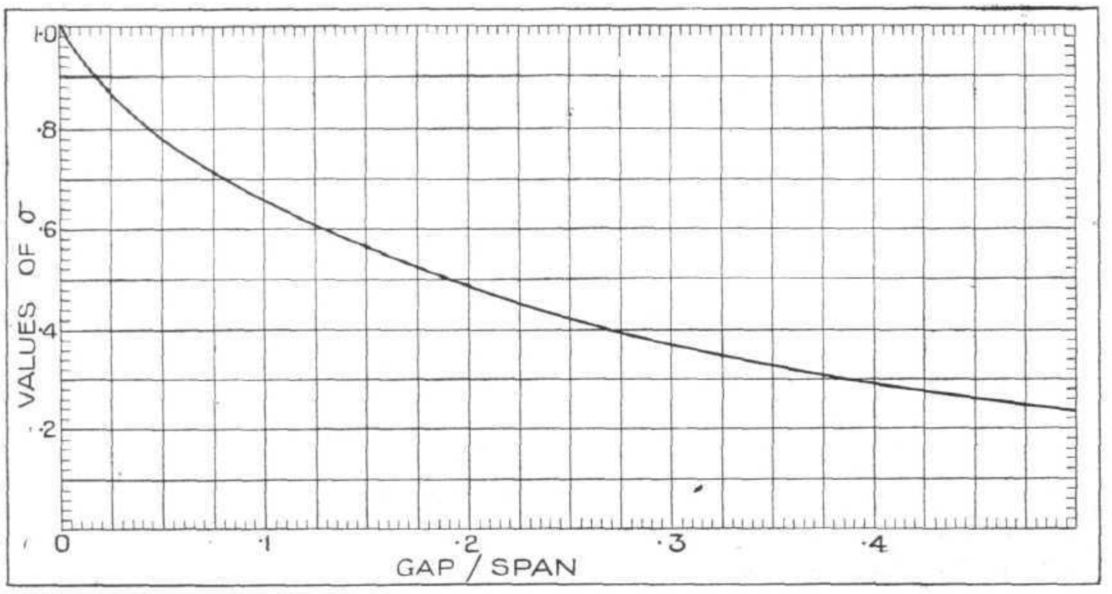


Fig. 11

wind channel results in Fig. 13 as a polar diagram, in accordance with the usual continental practice, because this form gives a much more graphic picture of the result. It will be noted that the minimum profile drags occur at $k_L = \cdot 02$, $k_L = \cdot 15$ and $k_L = \cdot 35$ respectively, and these values of k_L for the position of minimum k_D are in good agreement with the theoretical values given by $k_L = 2\pi\gamma$. The minima of the cambered sections do not, of course, occur at zero incidence, as the incidence of the tests is not measured from the lines joining the extremities of the centre lines and, in addition, does not refer to two-dimensional flow. The dotted parabolas are the appropriate induced drags, and the results are for models of aspect ratio 6 at $vl = 40$, corrected for channel wall constraint. It will be observed that the profile has a range of stable flow each side of the position of minimum k_D, and the k_L at which the flow breaks down is increased by increasing the k_L at which the minimum occurs.

Further characteristics capable of calculation are the angle of no lift* and the value of $\frac{dk_L}{d\alpha}$. This latter is a function of aspect ratio and can easily be calculated by the formulæ of Betz, already quoted. The following table shows a comparison between the calculated and observed values of the angle of no lift.

* See R. & M. 910.

	Calculated.			*Observed.*		
	RAF. 30	RAF. 31	RAF. 32	RAF. 30	RAF. 31	RAF. 32
Angle of no lift ...	0°	6·4°	7·7°	0°	6·2°	7·3°

This is one example of the accuracy with which calculation can predict the results of wind channel tests up to high-wind channel values of vl. How far the results are applicable to full scale is another matter, to be discussed later under scale effect.

The influence of induced drag on maximum k_L is not allowed for in the theory, as the theory does not hold at maximum k_L, where the flow is breaking down; but some rough indication of the influence of aspect ratio and biplane interference on maximum lift can be obtained by supposing that the angular range of stable flow from no lift to the stall is constant. The effect of thickness can also be estimated from the wind channel data of R. and M. 946, which shows that the value of k_L maximum increases by $4 \cdot 0\gamma$ for an increase of camber γ.

As the thickness of the wing section is controlled principally by structural considerations (*i.e.*, the depth of the spars), any property of the wing section which will influence the loads on the spars has an important bearing on its efficiency. For this reason no consideration of a wing section is complete without a study of the value of the centre of pressure movement;

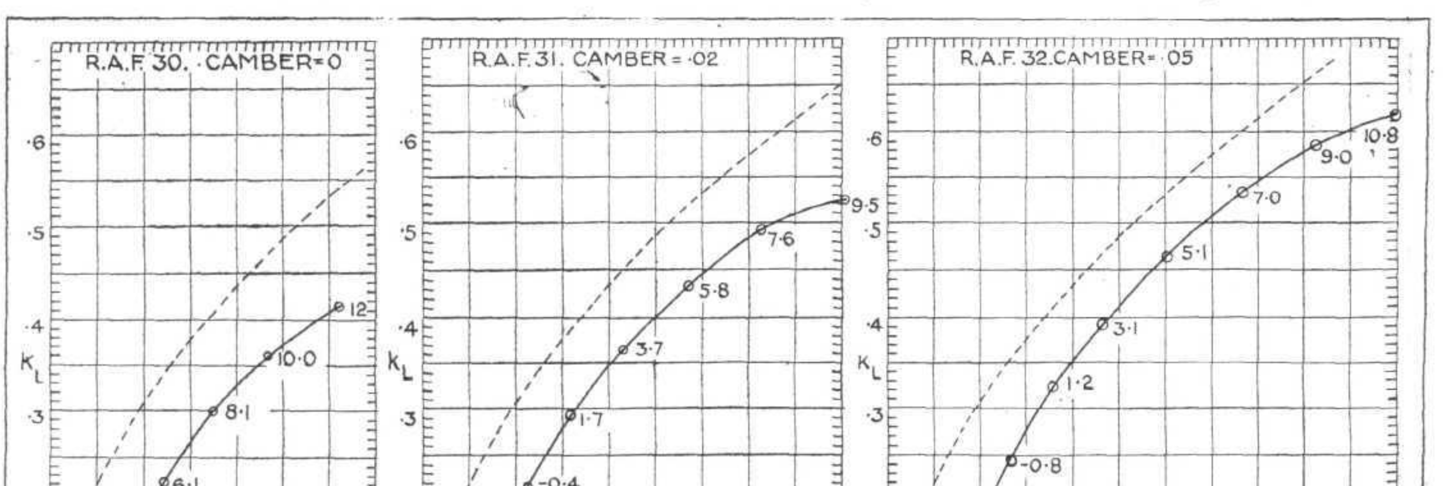


Fig. 13

and in this connection the criteria are the values of k_{m_0} (*i.e.*, k_m at zero lift) and $\frac{dk_m}{dk_L}$. The theory leads to the conclusion that the value of $\frac{dk_m}{dk_L}$ is constant and independent of wing section and aspect ratio, and experimental evidence in support of this conclusion is to be found in numerous published reports, *e.g.*, R. and M. 889, 928, &c. On the other hand, k_{m_0} is entirely determined by the centre line curvature, and as much by the shape of this line as by the actual value of the maximum camber. Thus, so long as we confine our attention to centre lines curved to the form of circular arcs, k_{m_0} is directly proportional to the camber $\left(k_{m_0} = -\frac{\pi}{2\gamma}\right)$, so that for cambers exceeding ·02 or ·03 k_{m_0}, and consequently the travel of the centre of pressure, becomes excessive. It has been shown, however, by Max Munk in Report No. 142 of the National Advisory Committee for Aeronautics and by H. Glauert in R. and M. 910 that the centre of pressure movement can be controlled by reflexing the centre line towards the tail, even to the extent of producing a stationary C.P. One expression for the centre line to obtain zero k_{m_0} is the cubic

$$y = hx\,(1 - x)\,(a - x)$$

and another section, R.A.F. 33, has been designed by the Royal Aircraft Establishment from R.A.F. 32 to reduce k_m to zero. The results of the wind channel tests are given below together with those for other sections designed on similar lines, so that the agreement between theory and experiment may be studied.

Aerofoil	R.A.F.25	26	30	31	32	33
Camber ...	·01	·02	0	·02	·05	·05
k_{m_0} Calculated	−·016	−·031	0	−·031	−·078	0
k_{m_0} Observed...	−·016	−·028	−·003	−·029	−·067	−·009

The effect of the full reflex curvature on R.A.F. 33 profile drag and max. k_L at vl 40 has been an increase of 10 per cent. in the former and a reduction of 6 per cent. in the latter as compared with R.A.F. 32.

There is one other aspect of the wing problem we must consider, namely, the methods of variation of the properties of the wing in flight. To vary the area is probably a mechanical impracticability, but some measure of adjustment can be made by varying the camber. The simplest mechanical form of carrying out camber variation is by the adjustment of a trailing flap, and by this means the maximum lift coefficient may be varied as much as 20 per cent. This device also varies the incidence of the wing in relation to the thrust line and obviates extreme changes of attitude of the whole aeroplane.

Increase in maximum lift, or more directly improvement of the stability of flow at high lift coefficients, is also obtained by the use of one or more slots arranged to force a sheet of air in such a direction as to restore the circulation and in consequence inhibit the forward travel of the rear stagnation point and the breakdown of flow. Practical combinations of the slot and trailing flap may give as much as 80 per cent. increase in maximum lift.

It must be remembered, however, that these devices can only be used for decreasing the chord. The choice of span and gap are independent considerations, and in consequence where the thickness or chord of the wing section is already determined by structural considerations, no advantage in top speed or climb is to be expected by the use of such devices. Naturally this will depend on the importance of the part that induced drag plays in performance, and also on the stalling speed considered necessary for safety. So far as induced drag is concerned, a glance at Fig. 10 will show that the choice of span will be fixed by considerations of the indicated air speeds at which the aircraft is required to operate (climb is, of course, included). Assuming for all-round purposes a stalling speed of 50/55 m.p.h. no practical advantages in performance from the use of slots or flaps are to be expected in military or commercial aircraft of normal type and all-round performances. As lower speeds are required, or the importance of *high indicated speed* preponderates, that is to say, as more importance is attached to speed range at ground level, the use of these devices becomes interesting. In cases such as fleet aircraft where dimensions are limited by purely external considerations the useful possibilities of slots and flaps are obvious.

(*To be continued.*)

DURALUMIN

By LESLIE AITCHISON, D.Met., B.Sc., F.I.C., M.I.A.E.

(*Continued from page 27.*)

The principal results indicated by the above tests respecting the mechanical properties of Duralumin may be summarised as follows. Material that has been annealed, and not subsequently heated to a temperature higher than 400° C. will have a maximum stress of about 16 tons per square inch. Material that has been annealed and then been heated to a temperature of near to 500° C. and quenched will have a maximum stress (after ageing) of 26 tons per square inch, approximately. If the annealed material is heated to a temperature of not more than 400° C. and is quenched, its resultant strength is not appreciably different from that produced in the material when cooled slowly from this same temperature. The tests recorded in the Tables 1 to 6, however, do not show the properties of Duralumin during the period of ageing after it has been heated to a temperature of 500° C. or thereabouts and quenched. These properties can be demonstrated most satisfactorily by actual test results. In Table 7 the results are given of a series of tensile tests taken upon samples of Duralumin which have been heated to a temperature of approximately 500° C., quenched in water, and allowed to age for a variety of periods before testing.

TABLE 7

Time after Quenching (hours).	Maximum Stress (tons/square inch).
0	16·5
1	16·8
2	17·5
5	18·5
10	21·5
15	23·5
20	24·5
25	25·0
30	25·5
35	26·0
72	26·5

The test results given in Table 7 indicate that Duralumin is quite as soft immediately after it has been quenched as when it has been annealed, but that this softness due to quenching is a very temporary possession. The material rapidly commences to harden, and, in the course of a few hours, has increased in tensile strength by several tons per square inch. As the time of ageing increases, the rate of increase of maximum stress with time falls off materially, and after a period of about four days the rate of increase has become negligibly small. There is ample evidence, however, to show that the curve of maximum stress against time never becomes absolutely parallel to the axis of time. It is perfectly clear that the rate of increase of strength is exceedingly small when a week or so has elapsed, but tests which have been made on Duralumin which has been aged for over ten years indicate that, during this very prolonged ageing period, there has been some small though definite increase in maximum stress. This increase in strength is of no importance at all in practice, but is interesting from a theoretical point of view, and is also important in the direction of indicating the nature of the instability of Duralumin, a matter which has frequently been commented upon.

The test results given above show that quenched Duralumin is in an unstable condition, and if the condition of the metal is viewed from the point of view of academic accuracy it would appear to be true to say that Duralumin is always in an unstable condition, and that, so far as we know, some change of properties is continuously going on within it.

What change of properties does occur is, however, of the nature of an improvement rather than the reverse, and the instability of Duralumin is represented by a process that results in a continuous improvement of the metal. For all practical purposes, however, it is clear that Duralumin has become stable after a period of ageing extending over, say, one week, and it is quite safe for any user of the metal to assume that the properties which Duralumin possesses after ageing for this period can be relied upon for the life of the material, provided that it is not subsequently re-treated in any way.

In the above tables, the highest quenching temperature of Duralumin has been quoted as 500° C. When judged by the resulting mechanical properties, this quenching temperature is a perfectly satisfactory one. Certain practical considerations, however, make it desirable not to heat Duralumin to quite such a high temperature. In actual practice, it is found to be much more desirable to quench the metal from a temperature between 480° C. and 490° C. So far as the mechanical properties of the metal are concerned, the difference produced by lowering the quenching temperature from 500° C. to 485° C. is negligibly small, but by employing the lower quenching temperature, certain definite advantages can be secured. The choice of the actual quenching temperature is naturally influenced by a variety of practical considerations. In the first place, it is clearly desirable that the temperature employed shall be one which produces the desired mechanical properties. In the second place, it is an axiom with respect to heat-treatment processes that they should be carried out at the lowest convenient temperature. Thirdly, with regard to Duralumin, it has to be remembered that over-heating the metal can be accomplished fairly easily and is accompanied by dangerous consequences.

It has already been stated in regard to the first point that a quenching temperature of 485° C. produces mechanical properties which are, to all intents and purposes, as good as those secured by quenching from 500° C. Respecting the second point, it is important to notice that 480° C. represents just about the minimum temperature from which Duralumin can be completely hardened with any safety. If the temperature of quenching is lowered below 475° C., the full mechanical properties are not obtained, and the use of such temperatures must be condemned. This consideration, therefore, fixes the quenching temperature at 480° C., or above. The upper limit of the quenching range is, as usual, determined by other considerations than the mechanical properties of the finished article. That the danger zone in the heat treatment of the metal is very easily approached will be appreciated when it is realised that incipient melting of Duralumin occurs at a temperature of 545° C. The metal does not become wholly molten at this temperature, but certain constituents melt, and, of course, if anything of this kind occurs, the material is entirely ruined. It also will be appreciated, since the heat treating temperature range is comparatively near to the melting range of the metal, that the material is exceedingly soft when heated to the quenching temperature. If the metal is heated to the upper part of the quenching range, it is softer than when heated to the lower end of the range, and, therefore, is more liable to severe distortion. Articles of an irregular shape, under these circumstances, will naturally tend to warp and may go right out of shape, even before quenching has occurred.

The third danger which is encountered by heating to the higher end of the range is that of blistering in a marked degree. There is no need to enter particularly into details of the causes of blistering, and it is sufficient to notice that the higher the temperature to which Duralumin is heated, the more this trouble is likely to be encountered. The formation of blisters is, of course, something to be avoided carefully, and to this end it is obviously desirable to utilise as low a quenching temperature as possible. The fourth disadvantage of over-heating is connected with the mechanical properties of the material. If Duralumin is heated to and quenched from temperatures much above 500° C., it will (after ageing) have a maximum stress not appreciably different from that produced by quenching from a temperature of, say, 485° C., but the metal will be distinctly more brittle. Here, again, the treatment of Duralumin is very parallel to that of steel, and the known effects of seriously over-heating steel are to a considerable extent reproduced in the treatment of Duralumin. Over-heated Duralumin is inferior in elongation and in toughness when compared with material that has been quenched from the correct quenching temperature.

All these considerations, therefore, lead to the fixing of a narrow range within which Duralumin can be safely and profitably heated prior to quenching. The low side of the range is fixed by the mechanical properties at an absolute minimum of 475° C. The upper point of the range is fixed by the dangers of over-heating at a temperature of about 500° C. A prolonged experience of the treatment of Duralumin leads definitely to the conclusion that the metal should be heated prior to quenching to a temperature between 480° and 490° C.

Briefly, then, the heat-treatment of Duralumin intended to produce the optimum mechanical properties consists in heating the metal to a temperature between 480° C. and 490° C. followed by rapid cooling, in turn followed by ageing for a period of about four days. As a result of this treatment, the material possesses a maximum stress of approximately 26 tons per square inch. Material that has been treated in this manner is referred to as "normal" by the makers. If the material is required to be soft, it can, of course, be annealed, and the test figures given in Tables 1 and 3 indicate that the softening can be carried out quite satisfactorily by re-heating the metal to a temperature between 300° and 400° C. The most suitable temperature range for annealing the material is between 350° and 380° C. Between these temperatures Duralumin loses entirely the effects of previous heat-treatments, and also previous cold working. If it is heated below 350° C., the material is not as soft as it might be, whilst if it is heated over 380° C. it commences to harden again to a small degree. Naturally, this last hardening is to a considerable extent a function of the rate of cooling from the annealing temperature. If the material was cooled slowly enough, even from a temperature of 450° C., it would be quite soft. In practice, it is difficult to ensure that the material shall cool sufficiently slowly to be entirely and permanently soft, even when cooling from a temperature of 400° C., and it is desirable, therefore, to utilise the temperature indicated, namely, from 350° to 380° C., for this purpose.

When annealing Duralumin the mass of the article should be taken into account to some extent. With a large mass, which will naturally cool fairly slowly, it is comparatively safe to heat the metal to a temperature near to 400° C. Thin parts of small mass are better treated at the lower end of the annealing range, that is, round about 350° to 360° C., thereby reducing the liability to slight hardening. Even in parts of small mass, the hardening that may occur is only slight, and does not show itself in the metal, except after fairly prolonged standing. If the metal, after cooling from the annealed temperature, is utilised immediately, there is no appreciable danger in annealing it anywhere within the recommended annealing range. If, however, material in thin sections is allowed to cool in the ordinary way, and then not worked at all for three or four weeks, it will be found to have hardened quite appreciably in this time. Parts of a larger mass, treated in the same way, will not have hardened appreciably, simply because of the very much lower rate of cooling.

Another point which emerges from a consideration of the heat-treatment of Duralumin is that of the properties of the metal immediately after quenching. The detailed results given above indicate that the metal immediately it is quenched is quite soft, and, in fact, that it has mechanical properties very similar to those of annealed metal. This softness only persists for quite a short time, but whilst this condition does exist it can be utilised very effectively. During the period that quenched Duralumin remains soft—that is, within, say, an hour or two of quenching—the material can be worked with just as much facility as if it was annealed. In some respects, the material appears to work even better in the quenched condition than in the annealed state, and it is frequently very convenient to utilise this period of softness for carrying out shaping and deformation of various kinds. Whilst the

metal is soft, it can be worked to just the same extent as when it is annealed, but the quenched material after this working will proceed to age harden, and, under these circumstances, need not be re-heated and re-quenched. This fact is very valuable, because it avoids distortion. Shaped Duralumin articles, when quenched, are very prone to distort severely, and the distortion has generally to be overcome by some method of straightening, such as re-rolling or re-drawing or re-pressing. If the forming can be done whilst the metal is soft immediately after quenching, the article will harden *in shape*, and need not be put through the tools once again. Naturally, it is necessary for the forming to be completed within about two hours after quenching, or else the material will have become too hard to work. It can also be stated quite definitely that the plastic deformation of Duralumin immediately after quenching has no deleterious effect upon its mechanical properties at all, as evidenced by the properties after ageing has taken place. It is also fairly clear that working the metal accelerates the ageing process to some extent. This is no disadvantage, and the final properties of the metal are quite as good as those of material which has been quenched and aged without any intermediate working at all.

(*To be continued.*)

TECHNICAL LITERATURE.

A.R.C. REPORTS.

FULL-SCALE AND MODEL MEASUREMENTS OF LIFT AND DRAG OF BRISTOL FIGHTER WITH R.A.F. 31 WINGS.

BY B. D. CLARK, B.SC., R. G. HARRIS, M.A., D.SC., AND L. E. CAYGILL, B.SC. PRESENTED BY THE DIRECTOR OF SCIENTIFIC RESEARCH.

R. & M. No. 990 (Ae. 201) (6 pages and 7 diagrams). September 1925. Price 6*d*. net.

The use of thick wing sections is becoming more important with the development of certain types of modern aeroplanes, and the present report describes the first of a series of model and full-scale comparisons of the lift and drag of biplanes using these sections.

Lift and drag have been measured both in the wind tunnel and on the full scale aeroplane on a Bristol Fighter fitted with thick wings of R.A.F. 31 section.

A large scale effect on maximum lift is disclosed, the figures being 0·635 full scale as against 0·525 at the highest VL of the model.

Similar tests will be available shortly on the section R.A.F. 32 and the symmetrical section R.A.F. 30 is also being prepared for flight.

THE FULL-SCALE DETERMINATION OF THE LATERAL RESISTANCE DERIVATIVES OF A BRISTOL FIGHTER AEROPLANE.

By H. M. GARNER, M.A., and S. B. GATES, B.A. PRESENTED BY THE DIRECTOR OF SCIENTIFIC RESEARCH.

R. & M. No. 987 (Ae. 199) (16 pages and 9 diagrams). August, 1925. Price 1*s*. net.

The most important part of recent work on stability at ordinary flying attitudes has been carried out on a standard Bristol Fighter. The full-scale experiments have been made at the Royal Aircraft Establishment, and the model experiments in the Duplex tunnel of the National Physical Laboratory. Reference should be made to the published reports R. & M. 897* and 932† for other work on this aeroplane.

Reasons for Inquiry.—These experiments were undertaken to determine for one aeroplane the full scale values of the aerodynamic quantities which determine lateral stability and so to place upon a sounder basis the prediction of stability which had hitherto rested upon model tests unconfirmed by direct measurements in flight.

* R. & M. 897. "The Lift and Drag of Standard Bristol Fighter Aeroplane." By the Ae. Staff of the R.A.E.
† R. & M. 932. "Force and Moment Measurements at Various angles of Yaw."—Section I by Irving & Batson, Section II by Frazer, Batson and Gadd.

Straight glides were carried out at an incidence of 10° with different amounts of sideslip on a Bristol Fighter, (1) with no applied moment, (2) with an applied rolling moment produced by carrying a weight on one wing tip, (3) with an applied yawing moment produced by attaching a parachute to an outer wing strut. Measurements were made on these glides of the angle of yaw, and aileron and rudder angles. From these measurements the lateral derivatives due to sideslip, aileron angle and rudder angle were calculated.

The agreement of the full scale results with those of model tests is quite satisfactory on the whole, but there are some discrepancies which require further investigation.

It is proposed to attempt to determine the derivatives depending upon rate of turn and rate of roll in the near future.

FULL-SCALE DETERMINATION OF THE LIFT AND DRAG OF AN AVRO TYPE 504 K AT LARGE ANGLES OF INCIDENCE AND COMPARISON WITH MODEL RESULTS.

By R. G. HARRIS, M.A., D.Sc., and C. HOWARTH, A.F.R.Ae.S.

Presented by the Director of Scientific Research. R. & M. No. 991 (Ae. 202). (7 pages and 7 diagrams.) April, 1925. Price 9*d*. net.

The work of the Stability and Control Panel on the subject of the control at low speeds has been discussed at length in R. & M. 1,000, "The Lateral Control of Stalled Aeroplanes. General Report by the Stability and Control Panel." In connection with this work, flight tests were made to measure the performance of the Avro aeroplane at large angles of incidence, and the present report describes these tests and gives also a comparison of full-scale and model results.

Total lift and drag were determined against angle of incidence for the Avro type 504K from 4° to 28° from measurements on glides with engine switched off, and corresponding wind-channel measurements were made on a one-tenth scale model at 50 ft. per second.

It was found that, with practice, steady flight was possible up to 30° incidence and quite reliable results could be obtained. The agreement of full-scale and model results is fairly good. The error on speed as measured by the standard pressure-head rises to 14 per cent. at 30° incidence.

These Reports are published by His Majesty's Stationery Office, London, and may be purchased directly from H.M. Stationery Office, at the following addresses: Adastral House, Kingsway, W.C. 2; 28, Abingdon Street, London, S.W. 1; York Street, Manchester; 1, St. Andrew's Crescent, Cardiff; or 120, George Street, Edinburgh; or through any bookseller.

AMERICAN NATIONAL ADVISORY COMMITTEE REPORTS.

The National Advisory Committee for Aeronautics in the United States of America corresponds to our own Aeronautical Research Committee. Two distinct classes of reports are issued, the first being known as *Technical Reports*. These Technical Reports are printed, and are illustrated by photographs and/or drawings. The second class are known as *Technical Notes*, and are issued in mimeographed form so as to enable them to be rapidly distributed to a somewhat smaller, but directly interested, circle of readers. Copies of the Reports and Notes may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D.C., U.S.A., but the American N.A.C.A. have a Technical Assistant in Europe, whose office is at 18, Rue Tilsitt, Paris, from whom copies can usually be obtained thus saving a certain amount of time.

The average price of the Technical Reports is 10 cents, which is, of course, remarkably cheap in view of the information contained, and in some instances the price is as low as 5 cents.

In the last issue of THE AIRCRAFT ENGINEER we published summaries of some of the N.A.C.A. Reports published during 1925. This week we continue with the remaining.

Summaries of Technical Reports Published in 1925

(*Continued from page* 36)

Report No. 214, entitled "Wing Spar Stress Charts and Wing Truss Proportions," by Edward P. Warner, Massachusetts Institute of Technology.—In order to simplify the calculation of beams continuous over three supports, a series of charts have been calculated giving the bending moments at all the critical points and the reactions at all supports for such members. Using these charts as a basis, calculations of equivalent bending moments, representing the total stresses acting in two-bay wing trusses of proportions varying over a wide range, have been determined, both with and without allowance for column effect. This leads finally to the determination of the best proportions for any particular truss or the best strut locations in any particular airplane. The ideal proportions are found to vary with the thickness of the wing section used, the aspect ratio, and the ratio of gap to chord.

Report No. 215, entitled "Air Forces, Moments, and Damping on Model of Fleet Airship *Shenandoah*," by A. F. Zahm, R. H. Smith, and F. A. Louden.—To furnish data for the design of the fleet airship *Shenandoah*, a model was made and tested in the 8 by 8 foot wind tunnel for wind forces, moments, and damping, under conditions described in this report. The results are given for air of standard density, $\rho = 0\cdot00237$ slugs per cubic foot without VL/v correction, and with but a brief discussion of the aerodynamic design features of the airship. This account is a slightly revised form of Report No. 195, prepared for the Bureau of Aeronautics, July 22, 1922, and by it submitted for publication to the National Advisory Committee for Aeronautics.

Report No. 216, entitled "The Reduction of Airplane Flight Test Data to Standard Atmosphere Conditions," by Walter S. Diehl and E. P. Lesley.—This paper was prepared for the National Advisory Committee for Aeronautics in order to supply the need of practical methods of reducing observed performance to standard conditions with a minimum of labour. The first part gives a very simple approximate method of reducing performance in climb, and is particularly adapted to work not requiring extreme accuracy. The second part gives a somewhat more elaborate and more accurate method which is well suited to general flight test reduction. The third part gives the conventional method of calibrating airspeed indicators and reducing the indicated speeds to true airspeeds. An appendix gives working tables and charts for the standard atmosphere.

Report No. 217, entitled "Preliminary Wing Model Tests in the Variable-Density Wind Tunnel of the National Advisory Committee for Aeronautics," by Max M. Munk.—This report contains the results of a series of tests with three wing models. By changing the section of one of the models and painting the surface of another, the number of models tested was increased to five. The tests were made in order to obtain some general information on the air forces on wing sections at a high Reynolds number, and in particular to make sure that the Reynolds number is really the important factor, and not other things like the roughness of the surface and the sharpness of the trailing edge.

The few tests described in this report seem to indicate that the air forces at a high Reynolds number are not equivalent to respective air forces at a low Reynolds number (as in an ordinary atmospheric wind tunnel). The drag appears smaller at a high Reynolds number and the maximum lift is increased in some cases. The roughness of the surface and the sharpness of the trailing edge do not materially change the results, so that we feel confident that tests with systematic series of different wing sections will bring consistent results, important and highly useful to the designer.

Report No. 218, entitled "Standard Atmosphere—Tables and Data," by Walter S. Diehl.—This report is an extension of National Advisory Committee for Aeronautics Report No. 147. Detailed tables of pressures and densities are given for altitudes up to 20,000 metres and to 65,000 ft. In addition to the tables the various data pertaining to the standard atmosphere have been compiled in convenient form for ready reference.

Report No. 219, entitled "Some Aspects of the Comparison of Model and Full-Scale Tests," by D. W. Taylor.—This paper was delivered before the Royal Aeronautical Society as the 1925 Wilbur Wright Memorial Lecture. It treats the subject of scale effect from the standpoint of the engineer rather than the physicist, in that it shows what compromises are necessary to secure satisfactory engineering model test data and how these test data compare with full scale or with theoretical values. The paper consists essentially of three parts: (1) A brief exposition of the theory of dynamic similarity; (2) application of the theory to airplane model tests, illustrated by test data on airfoils from the National Advisory Committee for Aeronautics variable-density wind tunnel; and (3) application of the theory to propeller testing, illustrated by comparisons of model and full-scale results.

Report No. 220, entitled "Comparison of Tests on Airplane Propellers in Flight with Wind-Tunnel Model Tests on Similar Forms," by W. F. Durand and E. P. Lesley.—The purpose of this investigation, which is the subject of this report, was to determine the performance, characteristics, and coefficients of full-sized air propellers in flight and to compare these results with those derived from wind-tunnel tests on reduced scale models of similar geometrical form.

The full-scale equipment comprised five propellers in combination with VE.7 airplane and Wright E.4 engine. This part of the work was carried out at the Langley Memorial Aeronautical Laboratory, between May 1 and August 24, 1924, and was under the immediate charge of Mr. Lesley. The model or wind-tunnel part of the investigation was carried out at the aerodynamic laboratory of Stanford University, and was under the immediate charge of Doctor Durand.

A comparison of the curves for full-scale results with those derived from the model tests shows that while the efficiencies realised in flight are close to those derived from model tests, both thrust developed and power absorbed in flight are from 6 to 10 per cent. greater than would be expected from the results of model tests.

Report No. 221, entitled "Model Tests with a Systematic Series of 27 Wing Sections at Full Reynolds Number," by Max M. Munk and Elton W. Miller.—A systematic series of 27 wing-sections, characterised by a small travel of the centre of pressure, have been investigated at 20 atmospheres pressure in the variable-density wind tunnel of the National Advisory Committee for Aeronautics.

The results are consistent with each other, and indicate that for such "stable" sections a small effective camber, a small effective S-shape and a thickness of 8 to 12 per cent., lead to good aerodynamic properties.

Report No. 222, entitled "Spray Penetration with a Simple Fuel Injection Nozzle," by Harold E. Miller and Edward G. Beardsley.—The tests covered by this report form a part of a general investigation of the application of fuel injection engine principles to aircraft engine service. The purpose of these tests was to obtain specific information on the rate of penetration of the spray from a simple injection nozzle, having a single orifice with a diameter of 0·015 inch when injecting into compressed gases.

The fuel was sprayed into a chamber fitted with glass walls and filled with nitrogen at various pressures. Special high-speed photographic apparatus, capable of taking a continuous series of 15 photographs at a rate of 4,000 per second, was used to record the development of single sprays. The effects of fuel pressures from 2,000 to 8,000 lbs. per square inch and chamber pressures from atmospheric to 300 lbs. per square inch on the rate of penetration and the development of the spray were studied.

The results have shown that the effects of both chamber and fuel pressures on penetration are so marked that the study of sprays by means of high-speed photography or its equivalent is necessary if the effects are to be appreciated sufficiently to enable rational analysis. It was found for these tests that the negative acceleration of the spray tip is approximately proportional to the 1·5 power of the instantaneous velocity of the spray tip.

Report No. 223, entitled "Pressure Distribution on the C.7 Airship," by J. W. Crowley, Jun., and S. J. De France.—

This investigation was made by the National Advisory Committee for Aeronautics at the request of the Bureau of Aeronautics, Navy Department, for the purpose of determining the aerodynamic pressure distribution encountered on a "C" class airship in flight. It was conducted in two parts: (a) Tests on the tail surfaces in which the pressures at 201 points were measured and (b) tests on the envelope in which 190 points were used, both tests being made under as nearly identical flight conditions as possible, so that the results could be combined and the pressure distribution over the entire airship obtained.

The method of testing consisted of measuring the pressure by means of orifices located at the desired points connected to the tubes of a multiple liquid manometer. Simultaneous readings of all the pressures were obtained by photographing the manometer.

The results as presented in this report are mainly in tabular form, and may be very briefly summarised as follows:—

(1) The maximum local pressure encountered on a tail surface was 7·3 lb./sq. ft.

(2) The maximum total normal force on a complete tail surface was 352 lbs. or a C_{NF} of 0·316 occurring on the bottom fin and rudder during a "reversal" of the rudder.

(3) The maximum moment of the tail surface forces about the centre of buoyancy was 37,200 lb. ft.

(4) The investigation of the envelope pressures, while showing the general distribution of pressure satisfactorily, is practically useless in the determination of total aerodynamic forces on the airship.

(5) It is concluded that the pressures set up by a bump are larger than those obtained in manœuvring.

Report No. 224, entitled "An Investigation of the Coefficient of Discharge of Liquids through Small Round Orifices," by W. F. Joachim.—The work covered by this report was undertaken in connection with a general investigation of fuel injection engine principles as applied to engines for aircraft propulsion, the specific purpose being to obtain information on the coefficient of discharge of small round orifices suitable for use as fuel injection nozzles.

Flow of the liquids tested under high pressure was obtained with an intensifier consisting of a 5-in. piston driving a direct connected ¾-in. hydraulic plunger. The large piston was operated by compressed air and the time required for the displacement of a definite volume by the hydraulic plunger was measured with an electrically-operated stop watch. The coefficients were determined as the ratio of the actual to the theoretical rate of flow where the theoretical flow was obtained by the usual simple formula for the discharge of liquids through orifices.

Values for the coefficient were determined for the more important conditions of engine service such as discharge under pressures up to 8,000 lbs. per sq. in., at temperatures between 80° and 180° F., and into air compressed to pressures up to 1,000 lbs. per sq. in. The results show that the coefficient ranges between 0·62 and 0·88 for the different test conditions between 1,000 lbs. and 8,000 lbs. per sq. in. hydraulic pressure. At lower pressures the coefficient increases materially.

It is concluded that within the range of these tests and for hydraulic pressures above 1,000 lbs. per sq. in. the coefficient does not change materially with pressure or temperature; that it depends considerably upon the liquid, decreases with increase in orifice size, and increases in the case of discharge into compressed air until the compressed-air pressure equals approximately three-tenths of the hydraulic pressure, beyond which pressure ratio it remains practically constant.

Report No. 225, entitled "The Air Forces on a Model of the Sperry Messenger Airplane Without Propeller," by Max M. Munk, and Walter S. Diehl.—This is a report on a scale-effect research which was made in the variable-density wind tunnel of the National Advisory Committee for Aeronautics at the request of the Army Air Service. A $\frac{1}{10}$-scale model of the Sperry Messenger airplane with U.S.A.5 wings was tested without a propeller at various Reynolds numbers up to the full-scale value. Two series of tests were made: The first on the original model which was of the usual simplified construction, and the second on a modified model embodying a great amount of detail.

While this report is of a preliminary nature, the work has progressed far enough to show that the scale effect is almost entirely confined to the drag. In the tests so far conducted, the drag at any given angle of attack within the normal flying range is found to vary as $\left(\frac{VL}{v}\right)^n$. The exponent n is constant for any one angle of attack, and ranges from − 0·045 at large angles of attack to − 0·17 at small angles.

It was also found that the model should be geometrically similar to the full-scale airplane if the test data are to be directly applicable to full scale. If the condition of geometric similarity be fulfilled, the data obtained at a full-scale value of Reynolds number agree very closely with free-flight data. The variable-density wind tunnel, therefore, appears to be a very promising instrument for procuring test data free from scale effect. It is also admirably suited for studying the scale effect and obtaining information which is necessary in an interpretation of the results obtained in atmospheric wind tunnels at low values of Reynolds number.

Report No. 226, entitled "Characteristics of a Boat-Type Seaplane During Take-Off," by J. W. Crowley, Jun., and K. M. Ronan.—This report, on the planing and get-away characteristics of the F-5-L, gives the results of the second of a series of take-off tests on three different seaplanes conducted by the National Advisory Committee for Aeronautics at the suggestion of the Bureau of Aeronautics, Navy Department. The single-float seaplane was the first tested and the twin-float seaplane is to be the third.

The characteristics of the boat type were found to be similar to the single float, the main difference being the increased sluggishness and the relatively larger planing resistance of the larger seaplane. At a water speed of 15 miles per hour the seaplane trims aft to about 12 deg. and remains in this angular position while plowing. At 2·25 miles per hour the planing stage is started and the planing angle is immediately lowered to about 10 deg. As the velocity increases, the longitudinal control becomes more effective, but over-control will produce instability. At the get-away the range of angle of attack is 19 to 11 deg., with velocities from the stalling speed through about 25 per cent. of the speed range.

Report No. 227, entitled "The Variable-Density Wind Tunnel of the National Advisory Committee for Aeronautics," by Max M. Munk and Elton W. Miller.—This report contains an exact description of the new wind tunnel of the National Advisory Committee for Aeronautics. This is the first American type wind tunnel. It differs from ordinary wind tunnels by its being surrounded by a strong steel shell, 35 ft. long and 15 ft. in diameter. A compressor system is provided to fill this shell—and hence the entire wind tunnel—with air compressed to a density up to 25 times the ordinary atmospheric density.

It is demonstrated in the report that the increase of the air density makes up for a corresponding decrease in the scale of the model. Hence such American type wind tunnel is free from scale effect.

The report is illustrated by many drawings and photographs. All construction details are described, and many dimensions given.

The method of conducting tests is also described and some preliminary results given in the reports. So far, the tests have confirmed the chief feature of this wind tunnel—absence of scale effect.

Report No. 228, entitled "A Study of the Effect of a Diving Start on Airplane Speed," by Walter S. Diehl.—Equations for instantaneous velocity and distance flown are derived for an airplane which crosses the starting line of a speed course at a speed higher than that which can normally be maintained in horizontal flight. A specific case is assumed and calculations made for five initial velocities. Curves of velocity, average velocity, and distance flown are plotted against time for each case and analysed. It is shown that the increase in average velocity due to a diving start may be very large for short-speed courses.

Report No. 229, entitled "Pressure Distribution over Thick, Tapered Airfoils, N.A.C.A. 81, U.S.A. 27C Modified, and U.S.A. 35," by Elliott G. Reid.—At the request of the

United States Army Air Service, the tests reported herein were conducted in the 5-ft. atmospheric wind tunnel of the Langley Memorial Aeronautical Laboratory. The object was the measurement of pressures over three representative thick, tapered airfoils which are being used on existing or forthcoming army airplanes. The results are presented in the form of pressure maps, cross-plan load and normal force coefficient curves and load contours.

The pressure distribution along the chord was found very similar to that for thin wings, but with a tendency toward greater negative pressures. The characteristics of the loading across the span of the U.S.A. 27C Modified are inferior to those of the other two wings; in the latter, the distribution is almost exactly elliptical throughout the usual range of flying angles.

The form of tip incorporated in these models is not completely satisfactory and a modification is recommended.

Report No. 230, entitled "Description and Laboratory Tests of a Roots Type Aircraft Engine Supercharger," by Marsden Ware.—This report describes a Roots type aircraft engine supercharger, and presents the results of some tests made with it at the Langley Field laboratories of the National Advisory Committee for Aeronautics. The supercharger used in these tests was constructed largely of aluminium, weighed 88 lbs., and was arranged to be operated from the rear of a standard aircraft engine at a speed of 1½ engine crankshaft speed. The rotors of the supercharger were cycloidal in form, and were 11 in. long and 9½ in. in diameter. The displacement of the supercharger was 0·51 cub. ft. of air per revolution of the rotors.

The supercharger was tested in the laboratory, independently and in combination with a Liberty-12 aircraft engine, under simulated altitude pressure conditions in order to obtain information on its operation and performance. During an investigation of the influence on the operation of the engine of various types of air-duct connections between the supercharger and the engine, the supercharger was subjected to considerable rough treatment, which it endured very well, so that it seems apparent that the supercharger could well endure service handling. By the proper proportioning of the air-duct system the engine would operate at all speeds as smoothly and free from vibration as the normal engine.

From these tests it seems evident that the Roots blower compares favourably with other compressor types used as aircraft engine superchargers, and that it has several features that make it particularly attractive for such use.

Report No. 231, entitled "Investigation of Turbulence in Wind Tunnels by a Study of the Flow about Cylinders," by H. L. Dryden and R. H. Heald.—With the assistance and co-operation of the National Advisory Committee for Aeronautics the Bureau of Standards has been engaged for the past year in an investigation of turbulence in wind tunnels, especially in so far as turbulence affects the results of measurements in different wind tunnels.

Two methods of making such studies are described in this report, together with the results of the use in the 54-in. wind tunnel of the Bureau of Standards. The first method consists in measuring the drag of circular cylinders; the second in measuring the static pressure at some fixed point. Both methods show that the flow is not entirely free from irregularities.

Report No. 232, entitled "Fuels for High-Compression Engines," by Stanwood W. Sparrow, Bureau of Standards.—From theoretical considerations one would expect an increase in power and thermal efficiency to result from increasing the compression ratio of an internal-combustion engine. In reality it is upon the expansion ratio that the power and thermal efficiency depend, but since in conventional engines this is equal to the compression ratio, it is generally understood that a change in one ratio is accompanied by an equal change in the other. Tests over a wide range of compression ratios (extending to ratios as high as 14·1) have shown that ordinarily an increase in power and thermal efficiency is obtained as expected provided serious detonation or pre-ignition does not result from the increase in ratio.

There are marked differences between fuels as regards the conditions under which they detonate or pre-ignite. It follows that the employment of a high-compression ratio is contingent upon securing a fuel which is suitable in its resistance to pre-ignition and detonation, and which at the same time possesses the other qualities essential to a satisfactory engine fuel.

This report is based very largely upon tests made at the Bureau of Standards during 1922, 1923 and 1924. It emphasises the fact that there may be a difference between a fuel's ability to resist detonation and its ability to resist pre-ignition. Although this report is primarily a general discussion of the properties essential to a satisfactory fuel for high-compression engines, certain fuels, benzol and alcohol in particular, are discussed in some detail.

List of Technical Notes Issued during 1925.

No.

205. The Logarithmic Polar Curve—Its Theory and Application to the Predetermination of Airplane Performance. By Val Cronstedt.
206. Structural Weight of Aircraft as Affected by the System of Design. By Charles Ward Hall.
207. The Simplifying Assumptions, Reducing the Strict Application of Classical Hydrodynamics to Practical Aeronautical Computations. By Max M. Munk.
208. Tests on Duralumin Columns for Aircraft Construction. By John G. Lee.
209. Tests of Rotating Cylinders. By Elliott G. Reid.
210. The Testing of Aviation Engines under Approximate Altitude Conditions. By R. N. DuBois.
211. Aircraft Engine Design. By E. E. Wilson.
212. Simplified Propeller Design for Low-powered Airplanes. By Fred E. Weick.
213. Discharge Characteristics of a High-Speed Fuel Injection System. By Robertson Matthews.
214. Note on the Katzmayr Effect on Airfoil Drag. By Shatswell Ober.
215. The Calculation of Wing-Float Displacement in Single-Float Seaplanes. By Edward P. Warner.
216. The Velocity Distribution Caused by an Airplane at the Points of a Vertical Plane Containing the Span. By Max M. Munk.
217. Note on the Air Forces on a Wing Caused by Pitching. By Max M. Munk.
218. The Estimation of Airplane Performance from Wind-Tunnel Tests on Conventional Airplane Models. By Edward P. Warner and Shatswell Ober.
219. The Comparison of Well-known and New Wing Sections Tested in the Variable-Density Wind Tunnel. By George J. Higgins.
220. The Drift of an Aircraft Guided Toward its Destination by Directional Receiving of Radio Signals Transmitted from the Ground. By Edward P. Warner.
221. Model Tests on the Economy and Effectiveness of Helicopter Propellers. By Max M. Munk.
222. Air Flow Investigation for Location of Angle of Attack Head on a JN4h Airplane. By R. G. Freeman.
223. Determination of the Lift and Drag Characteristics of an Airplane in Flight. By Maurice W. Green.
224. Pressure Distribution on the Nose of an Airship in Circling Flight. By Karl J. Fairbanks.
225. Propeller Scale Effect and Body Interference. By Fred E. Weick.
226. Wind-Tunnel Tests of Fuselages and Windshields. By Edward P. Warner.
227. Determination and Classification of the Aerodynamic Properties of Wing Sections. By Max M. Munk.

CORRESPONDENCE

The articles published in the March issue of THE AIRCRAFT ENGINEER appear not to have been of a controversial char cter, as they have provoked no discussion. Mr. Courtney's article in the February 25 issue on "Stalled Flight and Control" has, however, continued to draw correspondence, and in the April 1 number of FLIGHT, Professor B. Melvill Jones, of Cambridge University, wrote at some considerable length upon this subject. To his letter Mr. Courtney has not yet replied.

THE TAILLESS AEROPLANE

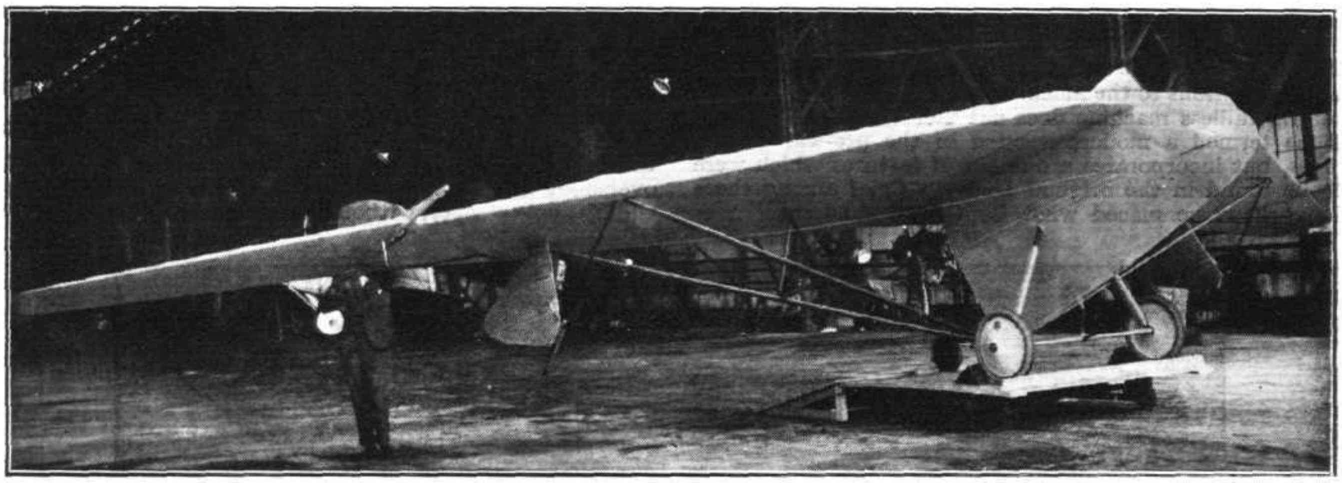
Dunne Type developed according to Modern Knowledge

THE paper read by Capt. G. T. R. Hill, M.C., M.Sc., A.F.R.Ae.S., before the Royal Aeronautical Society on April 22, proved a most interesting one. The author of the paper, as has been known for some considerable time, has been working away quietly on the evolution of a new type of aeroplane, or rather the development of an old type, since actually the type is not new, tailless aeroplanes having been built long before the war, and several of them flown with more or less success.

It is a somewhat curious fact that with the very considerable amount of experience with tailless aeroplanes the type should have been allowed to drop entirely at the outbreak of war, and that it should be taken up again seriously as a type which certainly appears at the moment to have certain not inconsiderable advantages.

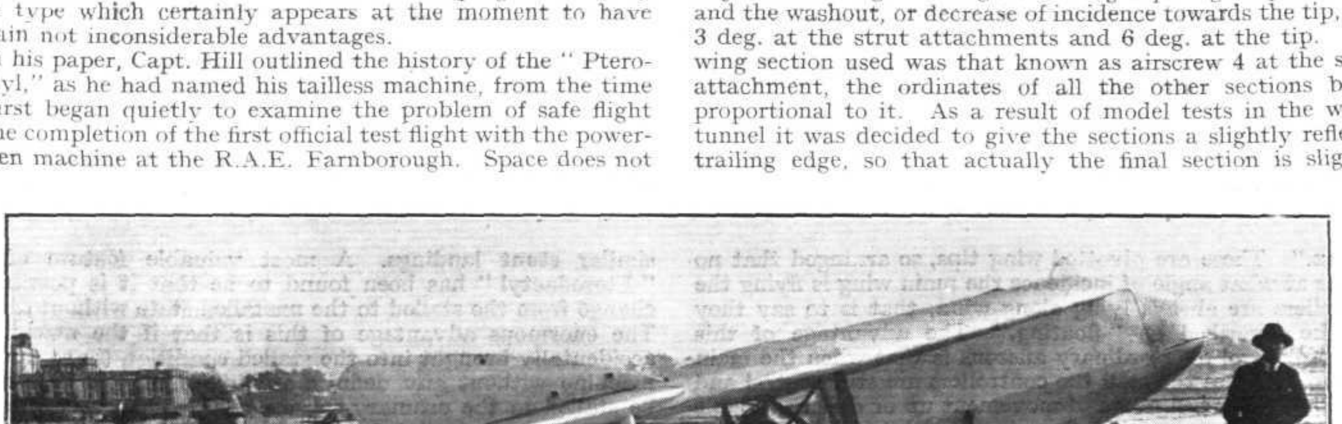
In his paper, Capt. Hill outlined the history of the "Pterodactyl," as he had named his tailless machine, from the time he first began quietly to examine the problem of safe flight to the completion of the first official test flight with the power-driven machine at the R.A.E. Farnborough. Space does not permit of following the lecturer through the whole of his paper, nor is this necessary, since those sufficiently interested in that side of the paper will be able to read it in full in a forthcoming issue of the Royal Aeronautical Society's Journal.

Capt. Hill began by contemplating the large number of fatal accidents occurring every year in the Royal Air Force, and he came to the conclusion that a very large percentage of these was due to loss of control. The task which he set himself was therefore that of designing an aeroplane which would never, through an error on the part of the pilot, get out of control. The lecturer showed a number of slides illustrating the power, or lack of power, of normal controls, and in the design of his machine he started off with the idea that the wing to be used should have a stationary centre of pressure. Two ways were open to attain this object: the reflexed trailing edge of a rectangular wing, and the swept back wing with diminishing angle of incidence towards the tips. After going into the subject Capt. Hill decided that the loss of maximum lift and L/D was likely to be less with the swept back wing than with the reflexed straight wing. He therefore chose the former type as the basis of his design, and gave the leading edge a sweep back of 31 deg., while that of the trailing edge was 14 deg. This gave a wing tapering in plan form, and the washout, or decrease of incidence towards the tip, was 3 deg. at the strut attachments and 6 deg. at the tip. The wing section used was that known as airscrew 4 at the strut attachment, the ordinates of all the other sections being proportional to it. As a result of model tests in the wind-tunnel it was decided to give the sections a slightly reflexed trailing edge, so that actually the final section is slightly different from airscrew 4, in that the trailing edge is raised 0·015 times the chord.



[R.A.F. Official Photograph. Crown Copyright.

THE TAILLESS AEROPLANE: Three-quarter front view of the Hill "Pterodactyl" with Bristol "Cherub" engine. The wing tips are pivoted to form "controllers" (ailerons and elevators). The rudders are mounted under the wing, and are provided with skids.



[R.A.F. Official Photograph. Crown Copyright.

THE TAILLESS AEROPLANE: Side view. Note the fixed vertical fins above the wing.

Attached to the wing, which is of fairly normal construction, is a short fuselage or *nacelle*, in the front of which is the pilot's cockpit, while in the power-driven machine the Bristol "Cherub" is mounted at the back of the *nacelle*, driving a pusher airscrew. The undercarriage legs run through the sides of this *nacelle* and the shock absorbers are placed inside. As the machine had been designed with rather high factors of safety, and as the space was not being otherwise utilised, it was

decided as an afterthought to turn the machine into a two-seater, by adding a second seat between the pilot and the engine. Under the tail end of the *nacelle* is fitted a small wheel supported by an arrangement not unlike that of the front forks of a bicycle, so as to allow the wheel to swivel. For steering on the ground the wheel is geared to the rudder bar.

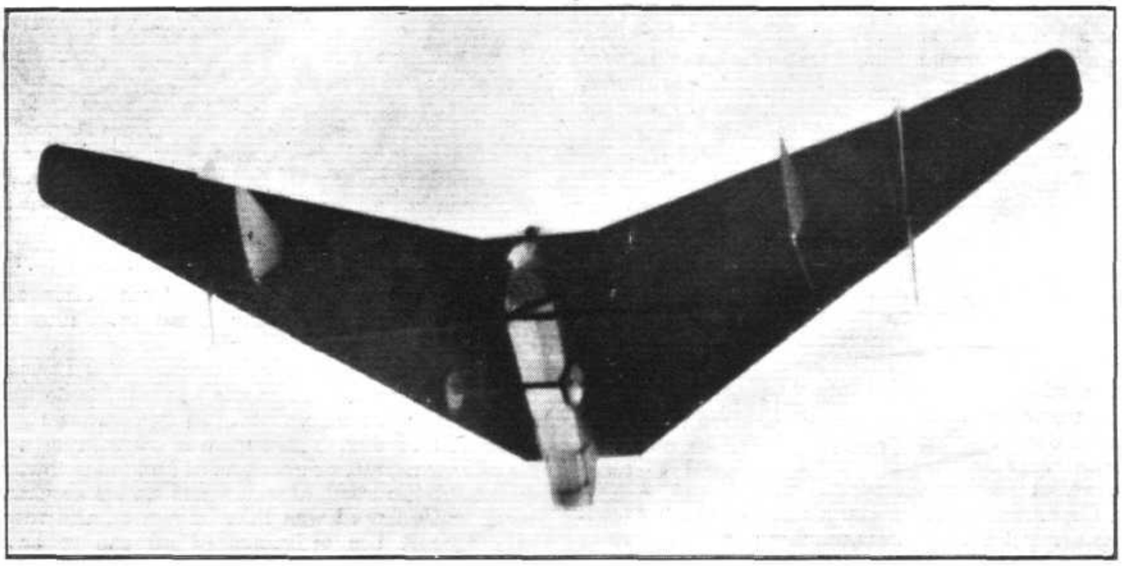
Capt. Hill first tested the machine as a glider and found that even at very low speeds the controls were effective, and having ascertained this, he proceeded to instal the engine so as to test the machine as a power-driven light 'plane. Up to this point Capt. Hill had been doing all the work of designing, and most of the construction himself, but the results were so encouraging that when he approached the Aeronautical Research Committee it was recommended that wind tunnel tests be carried out, and also that encouragement in the form of financial assistance and helpers, not to mention shed space, be given. Consequently, Capt. Hill was able to transfer the scene of his activities to the Royal Aircraft Establishment at Farnborough, where the installation of the engine and certain minor modifications to the machine were carried out.

The Hill tailless machine does not merely consist in what might be termed a modern version of the pre-war Dunne machines, but incorporates a number of features which were not to be found in the original Dunne. Chief among these should perhaps be placed what Capt. Hill calls the "controllers." These are pivotted wing tips, so arranged that no matter at what angle of incidence the main wing is flying the controllers are always lying along wind, that is to say they may be described as "floating." The advantage of this type of control over ordinary ailerons is that when the main wing approaches the stall the controllers are still neutral and thus have their full range of movement up or down available for control. As expected this was found to give adequate lateral control at angles which would be beyond the stall in an ordinary aeroplane. In point of fact Capt. Hill stated that the "Pterodactyl" did not show a decided stalling point, as does an ordinary normal aeroplane, and when following a flight path inclined approximately 45 deg., the machine itself is almost on a level keel. Actual flight tests had demonstrated that the "controllers" in the first machine were rather unnecessarily large (no less than one quarter of the total wing area) and in future machines it seems likely that the area of these controllers can safely be considerably reduced, while still retaining ample controllability. While on the subject of the "controllers" it should be pointed out that these serve, when operated separately, as ailerons, while when worked together up and down, being placed aft of the centre of gravity of the machine, their function is that of elevators.

The rudders of the Hill "Pterodactyl" are vertical surfaces, one on each side, placed below the wing and some considerable distance out. Normally these rudders are free to trail, and for turning to the right, for instance, the right rudder is turned so as to form an angle with the flight path of the machine. The resistance or drag thus set up on the right-hand side swings the machine to the right, since the left-hand rudder is still left trailing, and thus offers no extra resistance. It might have been thought that by now Capt. Hill had done all that could be expected or was necessary. He had secured adequate lateral and longitudinal control for all attitudes of the machine, and he had provided rudders which were equally effective for the work which they had to do. The inventor of the "Pterodactyl" was not, however, content with this, but decided that by providing a separate control for the rudders he could operate them in such a way that they would form air brakes. This was attained by setting the two rudders over at a large angle to the flight path, the rudders, of course, swinging out symmetrically—that is to say, the trailing edge of the right-hand rudder moving outwards to the right and that of the left-hand rudder to the left. As the centres of pressure of the rudders are approximately on a level with the centre of resistance of the whole aeroplane, the trim should not be appreciably altered by the use of the rudders as air brakes, and in actual flying tests this was found to be the case. Moreover, it was found that by moving the two rudders simultaneously to their full extent the resistance of the machine was approximately doubled. In other words, the gliding angle was halved. With the Hill "Pterodactyl" it is thus possible for a pilot, if he realises that he is likely to overshoot the mark, to put on his air brake, thus making the gliding angle steeper, without any necessity for side-slip or any similar stunt landings. A most valuable feature of the "Pterodactyl" has been found to be that it is possible to change from the stalled to the unstalled state without diving. The enormous advantage of this is that if the machine is accidentally brought into the stalled condition (in so far as a machine without any definite stalling-point can be said to be stalled in the ordinary sense of the word) when close to the ground, the pilot can bring it back to the unstalled condition without any appreciable loss of height. It would almost appear that if the "Pterodactyl" possessed no other advantage than that, this alone would be sufficient to make it worth while developing it further.

The designer of the "Pterodactyl" is, however, of the opinion that the tailless machine can be built with a smaller percentage structure weight than the normal machine. Another advantage is that it is possible to revert to the pusher type of aeroplane without loss of performance, while it is thought that an improvement can be made in the general arrangement of the flying-boat by employing the tailless design.

An appendix to Capt. Hill's paper contained the main data relating to the "Pterodactyl," and, as the figures are of considerable interest, they are given below. The machine has an overall span of 45 ft. The area of the main plane is 223 sq. ft., and the area of the controllers 55 sq. ft. The area of the rudders is 13 sq. ft. The weight empty varies slightly, according to whether large or small wheels are fitted to the undercarriage. With large wheels the empty weight is 458 lbs., and with small wheels 444 lbs. The weight of petrol and oil is 30 lbs., and of pilot 170 lbs. The total loaded weight of the machine as a single-seater is 658 lbs., and as a two-



[R.A.F. Official Photograph. Crown Copyright.

THE BOOMERANG: Plan view, from below, of the Hill tailless aeroplane "Pterodactyl." This view was secured with the camera pointing almost vertically upward.

seater 828 lbs. The wing loading of the two-seater is 3·7 lbs. per square foot, and the power loading 25 lbs. per horse-power. The speed range Capt. Hill stated to be from about 70 m.p.h. to about 30 m.p.h.

The Discussion.

The Chairman, Air Vice-Marshal Sir Sefton Brancker, Director of Civil Aviation, before throwing the paper open to discussion, pointed out that although the results obtained appeared to be very good it should be borne in mind that the Hill tailless machine was very lightly loaded. He recalled that in pre-war days the old B.E.2c was also very stable and was lightly loaded, and he would like to know what was likely to be the effect of heavy wing loading on a machine of this type. Concerning stability, Sir Sefton said that it was evidently possible to make machines of the ordinary type quite stable and he himself had made a flight in a machine at Detroit which was very stable indeed, so much so that it was possible for the pilot to let go of all the controls, and the machine flew itself for certainly several minutes. Sir Sefton also remarked that although Capt. Hill had got excellent results with a machine of the pusher type, he would like to know whether it was not possible that he might have got even better results with a tractor.

Mr. F. Handley Page referred to the early Handley Page machines which had backswept crescent shaped wings with stationary centre of pressure, and he recalled that on one of these machines, the biplane which was flown a good deal by Mr. Whitehouse, they actually removed the fixed tail plane, retaining only the elevators. (A photograph of this machine was published in FLIGHT of January, 3, 1914, which showed the machine in plan view from below.—ED.)

Squadron-Leader Haig, who has done a considerable amount of flying on the "Pterodactyl," said that the span of the machine was rather too great for it to be pleasant on the controls, particularly at top speed. In the neighbourhood of the stall, however, the machine began to show up to advantage. He also referred to the fact mentioned in the paper, that on landing and taxying the machine was rather unpleasant owing to the short wheel base, and it gave the pilot the feeling that the machine was going to turn over at any moment, and this he thought was due to the position of the pilot in relation to the undercarriage and was probably a thing which pilots could become accustomed to.

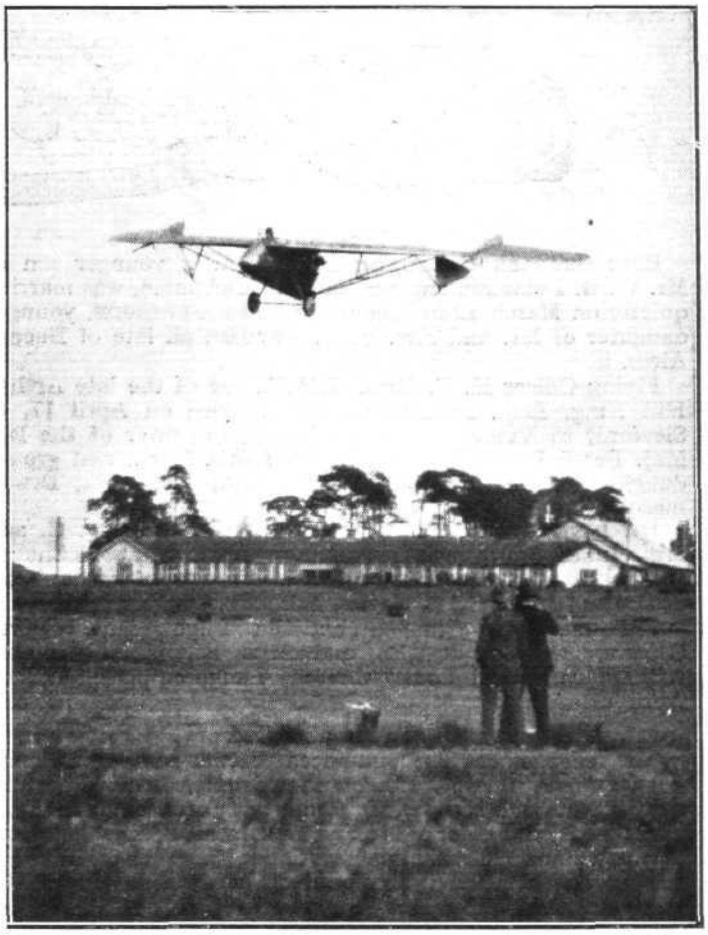
Prof. Melvill Jones said that what seemed to him encouraging was that in designing and building this machine Capt. Hill had shown that there was an opportunity for private individuals to do original research. The tailless machine seemed to give control after the stall in a most convenient manner. He also referred to the fact that with this tailless machine Capt. Hill seemed to have provided a possibility of bringing back the pusher type, which he thought was an advantage. Another great advantage which he saw in the tailless machine was the provision of the air brake, which made it possible for a pilot to control the gliding angle without the introduction of stunts.

Mr. McKinnon Wood said that to him it seemed that Capt. Hill's type of controls had an advantage over the slot and aileron control in that there was no tendency to produce autorotation and the safety of the machine in slow speed flying particularly appealed to him.

Maj. Wimperis, Director of Scientific Research, pointed out that there were now three distinct types being developed, and it would remain to be seen whether the slot and aileron type of control, the Cierva Autogiro, or the Hill tailless machine provided the best solution. The Air Ministry proposed to let Capt. Hill carry out further tests with the present machine and in addition it was intended to build one or two large machines so as to try out the design on a larger scale.

Mr. C. G. Grey asked whether the lecturer was aware of the work done in the early days of aviation by the late Mr. Jose Weiss. Mr. Weiss at first had no engine, and commenced by testing out his theories with gliders. Later on a power-driven machine was built and flown by Mr. Eric England. He would like the lecturer to point out how his tailless machine compared with the Weiss machines, and with the Austrian Ettrich monoplanes.

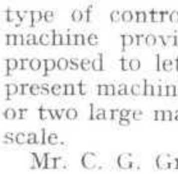
Replying to the various points raised in the discussion, Capt. Hill said he hoped the Air Ministry would assist in further experiments to find out how the tailless machine behaved with heavy wing loading. He also hoped to make experiments as to the relative merits of flying the machine as a pusher and as a tractor. One of the next steps would be to cut down the area of the controllers, which was expected to reduce the loads on the control stick without necessitating a sacrifice in controllability. In reply to Mr. Grey he was quite aware of the work done by the late Mr. Weiss, but he was under the impression that the Weiss machines had no controllers. The point had been raised whether the washout in angle of incidence did not adversely affect the efficiency of the machine. He thought possibly it might to some extent, but at the time he designed the machine he had very little information concerning suitable wing sections. By using some of the modern sections since developed, he thought it might be possible to avoid the wash-out.



[R.A.F. Official Photograph. Crown Copyright.

COMING IN TO LAND: The Hill "Pterodactyl" is seen in this view in a fairly normal attitude. Note that the "controllers" are trailing, *i.e.*, are lying along-wind, and form an angle with the main wing.

ROYAL AERONAUTICAL SOCIETY NOTICES



Lecture.—The title of Lieut.-Col. Richmond's lecture has been changed to "A Review of the Present Position with regard to Airship Research and Experiment." The lecture will take place in the Library at 7, Albemarle Street, W. 1, at 6.30 p.m., today (April 29).

Wilbur Wright Memorial Lecture.—The title of the Wilbur Wright Memorial lecture which is to be delivered by Mr. F. W. Lanchester, Honorary Fellow, at 6.30 p.m., in the Library at 7, Albemarle Street, W. 1, on Thursday, May 27, is "Sustentation in Flight." The gold medal which has been awarded to Mr. Lanchester by the Royal Aeronautical Society will be presented to him at this meeting.

THE ROYAL TOURNAMENT

THE Royal Tournament will open at Olympia on May 20 and will close on June 5. The Chairman of the Tournament is Major-General The Lord Ruthven, General Officer Commanding the London District, and the committee is representative of all branches of the Services. The units which are to give the displays this year embrace the Royal Navy, from the home ports; "O" Battery, R.H.A., from St. John's Wood Barracks; 10th Royal Hussars, from the 1st Cavalry Brigade, Aldershot (this being the regiment in which Prince Henry is serving); 17th/21st Lancers, from the same brigade; Royal Army Service Corps, Woolwich; the Brigade of Guards, London; the Equitation School, Weedon; the Army Physical Training Staff, Aldershot; the Royal Engineers; and the Royal Air Force.

Personals

Married

ERIC CHARLES DELAMAIN, M.C., R.A.F., younger son of Mr. W. G. Delamain and the late Mrs. Delamain, was married quietly on March 12 in London to MARY GERTRUDE, younger daughter of Mr. and Mrs. F. A. VYVYAN, all late of Buenos Aires.

Flying Officer H. E. KING, R.A.F., son of the late Arthur Hill King, Esq., Folkestone, was married on April 17, at Sleaford, to VIOLET DOROTHEA WOOD, daughter of the late Maj. Percy Wood, late Yorks and Lancs Regt., and grand daughter of the late John Turnly, Esq., J.P., D.L., Drummasole, Co. Antrim.

Dr. INNES SMITH, R.A.F., second son of the Rev. G. and Mrs. Innes Smith was married on April 8, at McCheyne Church, Dundee, to EVANGELINE MARGARET, elder daughter of Mr. and Mrs. WM. C. NAIRN, Ashbank, Dundee.

The marriage arranged between Flight-Lieut. DENYS GILLEY, D.F.C., R.A.F., and Miss KATHLEEN STOCKEN took place at All Souls' Church, Langham-place, W., on April 27.

To be Married

The engagement is announced between Major CHARLES A. DOHERTY, R.A.F., Henlow Aerodrome, Bedford, second son of Mr. and Mrs. D. P. Doherty, Toronto, Canada, to LILLIE, only daughter of Mr. and Mrs. JAMES SCOTT MORRISON, The Rachan, Helensburgh, Scotland.

The engagement is announced between Flying-Officer CECIL GEORGE PRIOR, R.A.F., only son of Mr. and Mrs. W. G. Prior, of Clapton, and MARGARET, youngest daughter of Mr. H. S. and the late Mrs. MILLER, of Stamford Hill.

The engagement is announced between Mr. "MIKE" PRITCHARD-BARRETT, R.A.F., second son of the late John Pritchard-Barrett and of the late Lady Gunter and step-son of the late Col. Sir Neville Gunter, Bart., of Wetherby Grange, Yorkshire, and WINIFRED MARY, third daughter of Mr. and Mrs. D'OYLEY RANSOM, of Normanton Manor House, Plumtree, Notts.

The engagement is announced between CHARLES F. ROUPELL, R.A.F., youngest son of the late Col. F. F. F. Roupell, E. Surrey Regt., and of Mrs. Roupell, of Shalford, Surrey, and DOROTHY UNA, elder daughter of Mr. and Mrs. J. JOHNSTONE KIRKE, of Rossend, Guildford.

Killed

Lieut. THOS. LAWE GUY BRYAN, R.M. (Flying Officer, R.A.F.), who was killed in a flying accident at Malta on March 30, was the only son of Maj. T. W. G. Bryan, of Mitcham Park, late of the Indian Army. He was 22 years of age.

Squadron-Leader HARLEY ALEC TWEEDIE, O.B.E., A.F.C., who was killed in a flying accident at Amman, Transjorden, aged 37, was the only surviving son of Mrs. Alec Tweedie (*née* Harley)

WALTER JOHN VEZEY, Lieut. R.E., attached Royal Bombay Sappers and Miners, who was killed on duty at Arawali, North-west Frontier, India, in a flying accident, on April 4, aged 25 years, was the second son of Mr. and Mrs. Peter Vezey, of 36, Queen's Avenue, Muswell Hill.

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MR. BASIL JOHNSON

The New Managing Director of Rolls-Royce, Ltd.

THE official announcement that Mr. Basil Johnson has been appointed Managing Director of Rolls-Royce, Ltd., can have occasioned surprise to very few. For the last ten years or so that he has been filling the position of General Manager of the firm he has been a veritable *alter ego* to his brother and shared with the late Mr. Claude Johnson the responsibilities of the organisation of that great enterprise, and the manufacture and sales of its famous cars and aero engines. He is also a director of Rolls-Royce of America, Inc., which has made such successful progress in recent years.

Mr. Basil Johnson, Managing Director of Rolls-Royce, Ltd.

It was in the early days of motoring that Mr. Basil Johnson, who has had unique and wide business experience, became an automobile enthusiast, and he was in fact Superintendent of the historic motor car exhibition, organised by the late Mr. Claude Johnson, at the Imperial Institute in 1896. Then, the call of "the well-ploughed, windy sea," led him to spend some years in the Merchant Service after which came a spell of railway building in South Africa. During the Boer war Mr. Basil Johnson was engaged in railway transport work, and in his subsequent years at the Cape he assisted in the development of the early motor transport in Africa. Convinced of the immense future for the petrol motor, Mr. Basil Johnson returned to England in 1904, and joined the Napier firm in that year. In the course of the following ten years he became well-known as the manager of their sales organisation at home and abroad. In 1914 he joined Rolls-Royce, Ltd., but on the outbreak of war he offered his services to the Royal Naval Air Service, and was appointed to the command of the great central aircraft supply depot at the White City. After some two years he was released by the Admiralty in order that he might take over the control of the Rolls-Royce company during the twelve months' absence of his brother, the late Mr. Claude Johnson, who was then engaged in the organisation of aero engine supplies in the United States. Since then he has continued as General Manager of the firm.

In his work and in his play, Mr. Basil Johnson retains the enthusiasm of youth, although he is of the same modest, courteous and retiring disposition as his late brother. In whatever capacity his activities may be employed, Basil Johnson firmly holds the respect of his fellow man. He takes an active interest in many sports; he can still enjoy a sail, and is quite a useful man on the hockey field, while at tennis, golf and skating he can hold his own. We tender him our congratulations and best wishes on his new appointment.

THE ROYAL AIR FORCE

London Gazette, April 20, 1926

General Duties Branch

Air Commodore Cyril L. N. Newall, C.M.G., C.B.E., A.M., is appointed Director of Operations and Intelligence, Air Ministry, and Deputy Chief of the Air Staff; April 12 (*vice* Air Vice-Marshal John Miles Steel, C.B., C.M.G., C.B.E.).

The following Flying Officers are granted permanent commns. in this rank (Jan. 1):—H. A. Anson, E. D. Barnes. The following Flying Officers are transferred to the Reserve:—*Class A.*—G. F. Blackburn; April 23. *Class C.*—A. L. Pearce; April 15. Flight-Lieut. F. M. Paul is placed on the retired list at his own request; April 17. The short-service commns. of the following Pilot Officers on probation are terminated on cessation of duty (April 21):—C. V. Godfrey, W. A. Hills.

Stores Branch

The following Flying Officers are granted permanent commns. in this rank (April 21):—J. H. P. Clarke, G. G. C. Pigott, F. A. R. Smith. Pilot Officer (on probation) C. P. Marshall is confirmed in rank; Feb. 10. Flying Officer J. R. Brown is confirmed in his appointment in Stores Branch; April 7.

Memoranda

The permission granted to following Second Lieutenants to retain their rank is withdrawn on their enlistment in Territorial Army:—C. A. J. Goodfellow, A. W. Mumord. The permission granted to Sec. Lieut. R. G. Kirk to retain his rank is withdrawn on his enlistment in Supplementary Reserve, Army; March 29.

Reserve of Air Force Officers

The following are granted commns. in Class A.A., General Duties Branch, as Pilot Officers on probation (April 6):—L. E. B. Alexander, W. T. W. Ballantyne, W. Scott. The following Pilot Officers are promoted to rank of Flying Officer:—W. F. A. Snell; Nov. 1, 1925. C. L. Atkinson; Feb. 4. R. W. Cawston; Feb. 4. A. B. Roche; Feb. 4. D. M. Tomlinson; Feb. 11. W. A. R. Speight; Feb. 24. The following are confirmed in rank (April 13):—*Flying Officer* D. Gardiner. *Pilot Officers.*—E. B. Fielden, C. Kenney, H. Rhodes.

The following Flying Officers are transferred from Class A to Class C:—F. E. Hills; May 23, 1925. E. F. Haselden; April 2. E. H. Bird; April 14. M. D. Allen; April 20. Flying Officer G. Clark is transferred from Class Dii to Class Di; April 15. The following Flying Officers relinquish their commissions on completion of service:—J. Edelsten, E. B. Wilson; March 10. H. E. Browne, N. H. Thackrah; April 20. The commission of Pilot Officer on probation V. Schofield is terminated on cessation of duty; March 28.

AUXILIARY AIR FORCE

Medical Branch

The following to be Flight-Lieutenant:—No. 602 *City of Glasgow (Bombing) Squadron.*—J. C. H. Allan, M.B.

ROYAL AIR FORCE INTELLIGENCE

Appointments.—The following appointments in the Royal Air Force are notified:—

General Duties Branch

Wing Commander R. Leckie, D.S.O., D.S.C., D.F.C., to H.M.S. *Hermes* for duty as Senior Air Force Officer, 30.3.26.

Squadron Leader G. H. Bowman, D.S.O., M.C., D.F.C., to H.Q., India, 30.12.25.

Flight Lieutenants: C. McM. Laing, M.C., A.F.C., to No. 6 Armoured Car, Co., Iraq, 28.3.26. J. G. Walser, M.C., to R.A.F. Depot, Uxbridge, on transfer to Home Estab., 14.4.26. T. M. Williams, M.C., D.F.C., to No. 406 Flight, Donibristle, 6.4.26. F. St. J. Woollard, A.F.C., to No. 24 Sqdn., Kenley, 1.5.26. T. P. Y. Moore, to Sch. of Tech. Training (Men), Manston, 1.5.26. E. T. Carpenter, A.F.C., to Station H.Q., Bircham Newton, 21.4.26. G. Y. Tyrrell, M.C., to No. 29 Sqdn., Duxford, 28.4.26. G. V. Howard, D.F.C., to Armament & Gunnery Sch., Eastchurch, 15.3.26. H. C. Irwin, A.F.C., to Sch. of Balloon Training, Larkhill, 23.4.26.

Flying Officers: S. F. Cole to H.M.S. *Hermes*, 10.4.26. H. G. Brookman, to No. 441 Flight, Mediterranean, 10.4.26. G. A. Kysh, to No. 6 Armoured Car Co., Iraq, 28.3.26. J. J. Nolan, to Aircraft Depot, Iraq, 11.3.26. A. P. Revington, to R.A.F. Base, Calshot, 20.4.26. B. L. Young, to Sch. of Army Co-operation, Old Sarum, 16.3.26.

NAVAL APPOINTMENTS

The following appointments were made by the Admiralty on April 20:—

Lieut.-Commander (Flying Officer, R.A.F.).—R. H. Portal, D.S.C., to *Eagle* and for No. 460 Flight (April 10).

Lieuts. (Flying Officers, R.A.F.).—G. F. Renwick and G. Willoughby, to *Hermes* and for No. 403 Flight; F. G. Wynne and F. H. G. Oliphant to *Hermes*, and for No. 441 Flight (March 15); A. N. Gray to *Eagle* and for No. 423 Flight; C. N. Lentaigne and P. D. Oliver, to *Eagle* and for No. 440 Flight (April 10).

IN PARLIAMENT

Lighter-than-Air Craft

Captain Garro-Jones, on April 21, asked the Secretary of State for Air the total number and description of lighter-than-air craft now in commission in the Royal Air Force?

Sir Samuel Hoare: Apart from a small kite balloon unit which is maintained for training purposes, there are no lighter-than-air aircraft now actually in commission in the Royal Air Force, but the R.33 and R.36 are available for commissioning if required.

Captain Garro-Jones: Can the right hon. gentleman say whether it has been decided to give up the development of these small, lighter-than-air craft?

Sir S. Hoare: No decision has been reached.

Brennan Helicopter

Sir Walter de Freece (for Mr. G. Harvey) asked the Secretary of State for Air whether Mr. Brennan has received from the Government, in connection with the Brennan helicopter, any other sum beyond the £7,000 which represents the difference between the £40,000 spent on labour, material and establishment charges at the Royal Aircraft Factory, plus £7,000 for salaries of the design staff, these amounts making up the sum given as the total of the expenditure on the helicopter?

Sir S. Hoare: The total expenditure upon the helicopter was stated as £55,000 in my reply to my hon. friend on March 31, and I assume, therefore, that he is now referring to the balancing figure of £8,000, not £7,000 as stated in the question. This figure of £8,000 represents approximately Mr. Brennan's salary for the seven years of his employment, and he received no further emoluments from the Government.

Sir W. de Freece (for Mr. G. Harvey) asked the Secretary of State for Air if the Brennan helicopter is still in the secret list; and, if not, are photographs of it available?

Sir S. Hoare: The patents relating to the helicopter have hitherto been treated as secret, and photographs are not available for publication. The whole question is, however, now under consideration.

Pilots (Age)

Colonel Day asked the Secretary of State for Air if he will, in view of the evidence given at the inquest on the officers and men killed at Henlow, consider the advisability of fixing a maximum age at which a man may be allowed to act as pilot?

Sir S. Hoare: I am advised that, provided a pilot retains the requisite standard of physical fitness and mental alertness, there is no need to lay down any maximum age limit beyond which he should not be allowed to fly. There is no reason why the necessary physical standards should not be maintained to the end of an officer's service life. Officers are periodically examined as to their physical fitness for the duties on which they are engaged, and unless they attain the requisite standard they are not allowed to fly.

War Histories

Mr. McNeill, on April 22, in reply to Captain Crookshank, who asked the Financial Secretary to the Treasury what progress is being made with the War histories, and how soon it is anticipated that no further expenditure will be required on the Estimates for this purpose, said, during his reply, the following volume of the Official War Histories had already been published—"Air History: War in the Air": one volume; and that one more volume of "War in the Air" would be published, it was hoped, within 12 months, and that two more would be required to finish "War in the Air."

THE HAMPSHIRE AEROPLANE CLUB

We have received some further particulars of the Hampshire Aeroplane Club, a notice regarding which appeared in our issue for April 15 last. The objects of the club, which was formed at a public meeting held in the Southampton Chamber of Commerce on March 2, are as follows:—(1) To bring together British subjects who are interested in flying; (2) to provide and maintain aeroplanes for the instruction and pleasure of members; (3) to train as pilots members who so desire.

The Club has accepted Messrs. A. V. Roe and Co.'s kind offer of the use of their large aerodrome at Hamble, together with very suitable accommodation for members and machines. Formal application for assistance under the Light Aeroplane scheme has been made to the Air Council, and negotiations are now proceeding.

The following entrance fees and subscriptions have been fixed by the Committee and await ratification at a general meeting: (*a*) Pilot, entrance fee £3 3*s.*, annual subscription £3 3*s.*; (*b*) Observer, entrance fee £2 2*s.*, annual subscription £2 2*s.*; (*c*) Associate, entrance fee 10*s.* 6*d.*, annual subscription 10*s.* 6*d.* To those joining immediately, the following reductions on entrance fees will be made: (*a*) first 50 applicants £1 1*s.*, second 50 applicants £2 2*s.*; (*b*) first 100 applicants, £1 1*s.*; (*c*) first 200 applicants, no entrance fee.

The privileges of the various grades of membership are as follows:—

Pilot.—Membership in this grade confers on unqualified pilots the right to receive instruction in flying, and on qualified pilots the right to hire the machines of the club.

The inclusive cost of flying instruction on club aircraft will be 25*s.* per hour. This rate will also apply when qualified pilots hire and pilot the machines themselves. Pilot members have the additional privilege of flying without charge in any club aircraft about to make a flight without a full complement of passengers.

Observer.—This grade is intended for those who desire to fly as passengers. They are entitled to a flight without charge whenever a seat is available in a machine about to fly. An observer member is guaranteed at least two flights per annum.

Associate.—This grade is for those who are interested in flying, but who do not wish to avail themselves of the special privileges of the pilot and observer grades. Associates are entitled to short flights at an inclusive charge of 5*s.* per flight.

Members of all grades are entitled to free admission to the aerodrome, club-rooms, and lectures.

All communications with reference to the club should be addressed to the hon. secretary: A. N. Clifton, 49, Bugle Street, Southampton.

THE ROYAL AIR FORCE MEMORIAL FUND

THE fortnightly meeting of the Grants Sub-Committee of the Fund was held at Iddesleigh House on April 15. Lieut-Commander H. E. Perrin was in the Chair, and the other members of the Committee present were:—Mrs. L. M. K. Pratt-Barlow, O.B.E., Mr. W. S. Field, Squadron-Leader E. B. Beauman. The Committee considered in all 13 cases, and made grants to the amount of £75 2*s*. 9*d*. The next Meeting was fixed for today (April 29) at 2.30 p.m.

THE second meeting of the year of the executive Committee of the Fund was held at Iddesleigh House on April 21. In the unavoidable absence of the chairman, Lord Hugh Cecil, P.C., M.P., the chair was taken by Air Marshal Sir John Salmond, K.C.B.

The secretary informed the Committee that 1,500 copies of the Annual Report for 1925 had been duly distributed to all concerned, to the press, and kindred societies, between the dates February 20 and 28 last.

It was announced that Vanbrugh Castle School, which is maintained by the fund for the education and upbringing of sons of deceased airmen, was reopened after the Easter holidays on April 21, with a complete roll of 39 boys. A further case of application for benefit arising out of the "Salting Benefaction" for the education of the son of a deceased officer was considered and approved.

It was announced that the Grants Sub-Committee at their fortnightly meetings, since the previous meeting of the Execute Committee on February 10, had dealt with 61 cases of appeal for assistance, and that in the same period the secretary had dealt with 79 cases.

The meeting, at its close, passed a resolution unanimously directing the Secretary to telegraph to the President of the Fund, H.R.H. the Duke of York, K.G., the hearty congratulations of the Committee on the happy event of the birth of a daughter, which took place at 17, Bruton Street on the day of the meeting, and which telegram has been very kindly acknowledged in a telegram received in reply from His Royal Highness himself, conveying his own and the Duchess of York's thanks for the message.

The next meeting of the Executive Committee as already fixed will take place at the offices of the Fund on June 9, at 3 p.m.

Napiers and Comandante Franco

ON April 15 D. Napier and Son, Ltd., gave a dinner in honour of Comandante Franco and his crew at the Palace Hotel, Madrid, at which about 35 well-known guests were present, including Gen. Soriano (late Chief of Military Aviation) who presided, Tenicute Col. Kindelan, Duque de Estremera (President of the Aero Club of Spain).

In presenting the members of the remarkable Transatlantic flight with a small memento of their exploit, Mr. Winter, on behalf of D. Napier and Son, Ltd., made the following speech:

"I am sure that you will understand the intense personal pleasure and satisfaction I feel in this meeting with the heroes of the Spanish-Argentine flight as the representative of the British firm of Napiers, and of the aero engine department of that firm.

"There are none who can know better than an aero engineer the tremendous feat which your aviators have performed, because we know the trying conditions an aero engine must withstand on such a flight, the strength and the endurance required, and we know also that all these qualities of the engines would be useless without even greater qualities in the men who control them—qualities of endurance both of body and mind, of purpose and spirit, of courage and daring, and of technical skill and knowledge.

"Our Napier Lion engines have been associated with many great feats of aviation, but with none which have required greater ability and courage on the part of the aviators, with none in which we have been allowed to share so glorious a triumph, with none which has raised such enthusiasm and admiration throughout the members of the Napier Company, from the directors down to the humblest worker.

"We have all felt honoured that Senor Franco selected the Napier Lion engines for his long and dangerous flight, and I greatly regret that my lack of knowledge of your language debars me from expressing as fervently as I should wish, the feelings of the Napier Company. My directors have, however, honoured me by sending me here to present to the members of the crew of the Ne Plus Ultra, a small gift to each as a memento of their exploit and as a slight tribute from the firm of D. Napier and Son, Ltd., which I trust you will honour them by accepting.

"I present this memento to you, Senor Franco, as the leader of this glorious exploit, together with the sincere wishes of my directors for your future success in carrying the colours of Spain to further triumphs in the air.

"To you, Senor de Alda, as a participator in the flight upon whom rested the great responsibility of navigating the Plus Ultra to its destination.

"To you Senor Duran who acted as observer on the flight.

"And to you Senor Rada, for seeing to it so well that the Napier Lions of England did their duty to the Air Lions of Spain—as I hope sincerely they will continue to do always and everywhere."

PUBLICATIONS RECEIVED

U.S. National Advisory Committee Reports. No. 216. The Reduction of Airplane Flight Test Data to Standard Atmosphere Conditions. By W. S. Diehl and E. P. Lesley. *No.* 219 Some Aspects of the Comparison of Model and Full-scale Tests. By D. W. Taylor. *No.* 224. An Investigation of the Coefficient Discharge of Liquids through Small Round Orifices. By W. F. Joachim. *No.* 227. The Variable Density Wind Tunnel of the National Advisory Committee for Aeronautics. By Max M. Munk and E. W. Miller. *No.* 230. Description and Laboratory Tests of a Roots Type Aircraft Engine Supercharger. By Marsden Ware. The United States National Advisory Committee for Aeronautics, Navy Building, Washington, D.C., U.S.A.

Technical Note No. 231. The Resistance to the Steady Motion of Small Spheres in Fluids. By R. A. Castleman. February, 1926. The United States National Advisory Committee for Aeronautics, Navy Building, Washington, D.C., U.S.A.

The Air League Bulletin. April, 1926. *Vol. IV. No.* 61. Air League of the British Empire, 26, George Street, Hanover Square, W.1. Price 4*d*.

The Rugby Engineering Society Proceedings, Session 1924-5. *Vol. XIX*. Industrial Engineering Department, British Thomson-Houston Co., Ltd., Rugby.

Rules and Programme, 1926. The Royal Air Force Rifle Association, R.A.F. Cadet College, Cranwell, Lincs.

Le Document Aéronautique. April, 1926. *Vol. I, No.* 1. Le Document Aéronautique, 40, Quai des Celestins, Paris.

AERONAUTICAL PATENT SPECIFICATIONS

***Abbreviations*: Cyl. = cylinder; i.c. = internal combustion: m. = motor. The numbers in brackets are those under which the Specifications will be printed and abridged, etc.**

APPLIED FOR IN 1924

Published April 29, 1926

31,146. O. GEISLER. Aircraft. (249,915.)

APPLIED FOR IN 1925

Published April 29, 1926

969. AIRSHIP GUARANTEE CO., LTD., and B. N. WALLIS. Mooring-masts or mooring-gear. (249,949.)

3,497. LORD INVERNAIRN (W. BEARDMORE) and A. E. L. CHORLTON. Casings for i.c. engines. (249,974.)

13,426. L. RENAULT. Aeroplanes. (245,408.)

13,467. A. TAMMEO, E. CAMINADA, P. FOPPIANO, and C. SCOTTI. Aeroplanes in connection with their transverse and steering equilibrium. (236,177.)

21,774. H. JUNKERS. Rolling contact bearings for use with oscillating members. (242,600.)

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